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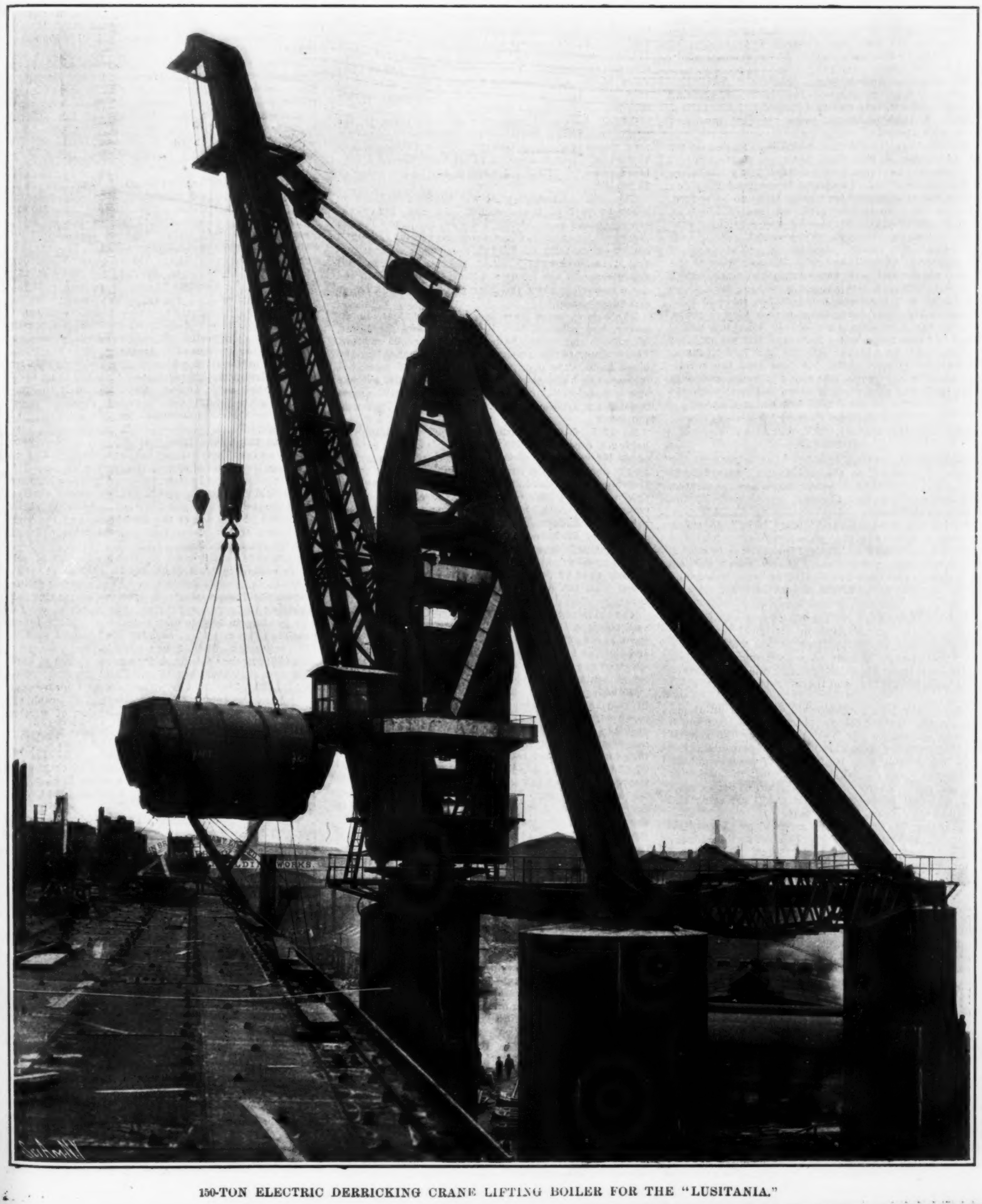


150-TON ELECTRIC DERRICKING CRANE LIFTING BOILER FOR THE "LUSITANIA."

150-TON ELECTRIC DERRICK CRANE.

By the English Correspondent of SCIENTIFIC AMERICAN.

FOR the purpose of facilitating the handling of the more bulky and weighty portions of machinery and other material required in the fitting out and completion of a large vessel, the Clydebank shipyards of Messrs. John Brown & Co., at Glasgow, have been equipped with a 150-ton electric derrick crane, which is claimed to be the largest appliance of this type in the world. The crane was especially designed and constructed for fitting out the new turbine Cunard vessel "Lusitania," which is now approaching completion at these yards, owing to the great height of the hull above the quay, combined with the great weight and dimensions of the boilers and machinery. The crane itself has been constructed by Cowans, Sheldons & Co., Limited, of Carlisle, and its massive proportions may be gathered from the following particulars: The jib has a radius with the maximum load of 150 tons over 65 feet; a maximum radius with loads up to 30 tons of 120 feet. The minimum radius for all loads is 27 feet; and the height of the jib above the quay at 65 feet radius is 176 feet. From quay level to top of mast is 120 feet; the distance from centers of sleepers, 64 feet; and the height of the sleepers above the quay, 44 feet.

The crane is carried upon a substantial foundation of three cylindrical piers. The latter, comprising steel cylinders, are 14 feet in diameter and are carried down to a depth of 60 feet below the quay level and filled with concrete.

The whole of the framing with the exception of the jib and diagonal sleeper is built up of steel plates and angles, the remaining portions being of lattice girder construction. The crane is equipped with two sets of lifting gear, one for lighter loads up to 30 tons, and the other up to the maximum load of 150 tons, both gears as well as the slewing and derricking gear being driven by separate series-wound motors each developing 65 brake horse-power. The gearing throughout is of steel, and with the exception of the barrel wheels and rack has machine-cut teeth. Each motion is provided with automatic braking gear, those for lifting and revolving being of the solenoid type, the derricking gear being fitted with a Weston brake.

With the maximum load of 150 tons the lifting speed is 4 feet per minute; 75 tons, 8 feet per minute; 30 tons load, 20 feet per minute; and light loads at 90 feet per minute. With 150 tons load the revolving speed is one revolution in six minutes, and with light loads one revolution in three minutes; with 150 tons the derricking speed is 5 feet per minute.

ELECTRICAL MACHINERY, APPARATUS, AND SUPPLIES.

BULLETIN 73, just published by the Bureau of the Census, is a report on the manufacture, according to the census of 1905, of electrical machinery, apparatus, and supplies, by Mr. Thomas Commerford Martin, expert special agent.

During the five-year period there have been extensive improvements in the utilization of electricity and electrical machinery and radical innovations in electrical devices for general use. These recent developments and inventions are treated at some length and in considerable detail in the present bulletin.

PROGRESS OF THE INDUSTRY.

In 1905 there were 784 establishments engaged primarily in the manufacture of electrical machinery, apparatus, and supplies. Their capital was $174,066,-026; the average number of wage-earners employed, 60,466, and their wages, $31,841,521; the cost of materials used, $66,836,926; and the value of products, $140,-809,369.

There have been increases since 1900 in all items, even in the number of establishments, an item which in most industries has been reduced by the general tendency toward consolidation. The percentages of gain are as follows: In number of establishments, 34.9 per cent; in capital, 108.1 per cent; in number of wage-earners, 43.9 per cent; in amount of wages paid, 54.7 per cent; in cost of materials, 35.1 per cent; and in value of products, 52.3 per cent.

In addition to the products reported by these establishments, there was an output of electrical machinery and supplies valued at $18,742,033, from 128 establishments engaged primarily in other lines of manufacture.

LOCALIZATION.

The distribution of electrical manufacturing throughout the States has remained the same in all essential respects at the two censuses. New York, Illinois, Ohio, Pennsylvania, Massachusetts, Connecticut, Indiana, and New Jersey reported 631 of the 784 establishments making electrical apparatus at the census of 1905 and products valued at $126,807,804, or 90.1 per cent of the total for the country. In value of products New York led, followed by Pennsylvania, Illinois, Massachusetts, New Jersey, and Ohio, in the order given. Their combined product constituted five-sixths (84.5 per cent) of the total value of products. Connecticut and Indiana did not reach the $5,000,000 mark.

The increase in total capital was distributed uniformly throughout the country, but was greatest in Pennsylvania, where capital increased from $20,967,587 to $58,393,011, or 178.5 per cent, although the value of products advanced only from $19,112,665 to $26,257,569, or 37.4 per cent. The capital and value of products of the other leading States were as follows: New York—capital, $30,643,167, and products, $35,348,276; Illinois—capital, $21,644,783, and products, $16,700,027; Massachusetts—capital, $12,735,427, and products, $15,-882,216; New Jersey—capital, $18,457,821, and products, $13,803,476; and Ohio—capital, $10,408,184, and products, $11,019,235.

The general well-being of the industry must be attributed to the prosperity of the great public service corporations, private and municipal—street railway companies, lighting plants, telegraph and telephone systems, etc.—by which the great bulk of electrical machinery is purchased.

DYNAMOS, MOTORS, BATTERIES, ETC.

The total value of dynamos and motors, which constitute the largest single class of electrical apparatus manufactured in the census year, was $33,454,860. A slight increase in the value of all dynamos (from $10,-472,576 in 1900 to $11,084,234 in 1905) was associated with a very large increase in number (from 10,527 to 15,080) and in capacity (from 770,832 horse-power to 1,328,243 horse-power). It is obvious that a relatively small increase in the average size of machines was accompanied by a large decrease in the cost per horse-power to the purchaser.

Of the total number of dynamos, 13,756, having a capacity of 853,800 horse-power and a value of $6,973,-130, were direct current and 1,324, with a capacity of 474,443 horse-power and a value of $4,111,104, were alternating-current. The number, horse-power, and value of the direct-current dynamos were greater in 1905 than in 1900, whereas the alternating-current dynamos increased in capacity only.

Closely associated with the dynamo class is the group comprising double-current generators, dynamotors, motor generators, boosters, and synchronous converters, of which there were in all 2,135, having a combined capacity of 279,552 horse-power and a value of $1,740,534.

The value of motors built was $22,370,626, twice as great as that of the dynamos. Of this, $13,120,948 represents the value of 79,877 motors for power (54,242 direct-current and 25,635 alternating-current), with a combined capacity of 678,910 horse-power. The general introduction of electric lighting in industrial establishments has brought with it an increase in the use of electric motors, the same plant furnishing power and illumination.

There have been increases in the number, horse-power, and value of both kinds of motors for power, of motors for fans, and of miscellaneous motors. Those designed for railways and automobiles, on the other hand, have decreased in number and value but increased in horse-power. The increase in the average size of the electric automobile motor is due to the more general use of the electric automobile for industrial purposes.

In 1905, 66,698 transformers were manufactured, having a capacity of 970,908 horse-power and a value of $4,468,567. The production of transformers has nearly doubled in the five-year period, testimony to the growing use of alternating current for lighting and power purposes. More than half the capacity of the transformers, namely, 504,009 horse-power, was comprised in transformers, 3,387 in number, which had a capacity of 50 kilowatts and upward. The effect of size on price is seen in the fact that these larger transformers were returned as valued at $1,176,360, or slightly over $2 per horse-power, a low figure as compared with the price of the 63,311 under 50-kilowatt capacity.

The value of switchboards intended for electric light and power and electric railway work has advanced from $1,846,624 in 1900 to $3,766,044 in 1905. Marble and slate as materials have generally supplanted wood, which at one time was universally used even on boards for currents of high voltage.

Batteries and their parts and supplies manufactured in 1905 had an aggregate value of $4,243,893, as compared with $3,679,045 in 1900. The actual product was probably greater, because their various elements are not always distinguishable as battery parts, and are therefore sometimes returned as "all other products." Of the aggregate, $2,645,749 represents the value of storage batteries, parts, and supplies; and $1,598,144 that of primary batteries, parts, and supplies. Of primary batteries, 1,734,801 were liquid and 4,888,361 dry; the value of the two kinds was about equal. The most extensive use of storage batteries is in connection with central-station electric-lighting plants and electric railways. Primary batteries, which have been found unsuited to relatively heavy work, have in many instances been replaced by small dynamo-electric outfits and by storage batteries. The production of dry batteries, however, has been stimulated by the development of the automobile, in connection with which they are universally used.

LIGHTING APPARATUS AND SUPPLIES.

The value of all classes of carbons reported for 1905 was $2,710,985. Although the total is more than one-half greater than in 1900, there was a falling off of over $200,000 in arc lamp carbons, due to the adoption of the modern inclosed arc lamp, which requires recarboning much less frequently than the open type which they have almost entirely replaced, and to the introduction of a new variety of lamp of the luminous arc type, the magnetite, which dispenses entirely with the carbon.

The number of arc lamps made in 1905, 195,157, was greater than in 1900, but their value, $1,574,422, was less by $253,349. A remarkable change has taken place in the relative importance of the two types—open and inclosed. The production of the former fell from 23,656, with $276,481 value, to 1,748, valued at $29,989; whereas the number of inclosed lamps advanced from 134,531 in 1900 to 193,409 in 1905. The large number of the latter has brought with it a reduction in cost, the value declining from $1,551,290 to $1,544,433. In addition to these arc lights, 1,924 searchlights and projectors, valued at $114,795, were made in 1905, a decrease since 1900 of 77 per cent in number and of approximately 50 per cent in value.

One of the largest specialized departments of electrical production is that of incandescent lighting. Incandescent lamps are made all over the country, but the largest output is from a plant in New Jersey. The total value has risen from $3,442,183 to $6,308,299. The principal gain both in quantity and value was in 16-candle-power lamps, which remain the standard, and advanced from 21,191,131 to 83,333,285 in number, and from $2,910,023 to $4,608,084 in value. A radical advance in this branch consists in the production of incandescent lamps with metallic filaments in place of carbon. Tantalum, osmium, and tungsten are used for the purpose.

The total number of decorative and miniature lamps, etc., in which class are included also vacuum tubes, vacuum and vapor lamps, and X-ray bulbs, was 1,584,-495 (about four times the number made in 1900) and their value was $644,906, as compared with $72,935 in 1900.

Electric light fixtures to a total value of $5,305,466 were made in 1905, a considerable increase over 1900. The increase is accounted for to a great extent by the larger manufacture of sockets and bases incident to incandescent lamps, but the bulk of the amount, $3,294,606, represents, as before, the fixtures themselves. The introduction of electric lamps of new forms has involved the manufacture of forms of fixtures unknown at the census of 1900.

TELEPHONE AND TELEGRAPH APPARATUS.

The total value of telephonic apparatus manufactured, as reported at the census of 1905, was $15,863,-698, as compared with $10,512,412 for the census of 1900. Of this total value, $824,204 represented the value of 850,815 transmitters; $696,113, the value of 831,195 receivers; $6,483,418, the value of 887,447 complete sets of instruments; $68,826, the value of 4,560 interior systems complete without instruments; $5,154,-447, the value of 4,283 central switchboards; $564,795, the value of 3,917 private exchange boards; and $2,071,-895, the value of telephone parts and supplies (chiefly the signaling apparatus in magneto-telephone sets and the line protector fuses, etc.).

Illinois is the great center of telephonic manufacturing industry in the United States, both as to number of factories and as to output. More than half the total product, or $8,357,521, was from this State. The output of New York was also large, but not quite half that of Illinois.

Recent inventions involving the use of telephonic apparatus are: A system of music production and distribution by means of electrical currents over the telephone circuits; the Poulsen telegraphone, the object of which is to furnish a record of the speech received over the telephone; a system of submarine signaling based on the use of the telephone; and the "telegraphone," an instrument used in connection with railway telegraph circuits.

An apparent falling off in the production of telegraph apparatus from $1,642,266 in 1900 to $1,111,194 in 1905 is accounted for in part by the growing custom among the larger telegraph systems of making and repairing their own apparatus. The value of the factory product in 1905 is distributed thus: 76,826 intelligence instruments (key, sounder, etc.), valued at $187,-744; police, fire, district, and miscellaneous, valued at $592,070; wireless telegraph apparatus, valued at $114,-050; and switchboards and parts and supplies, valued at $217,330. The most important recent improvements have been the introduction of printing telegraph systems and the development and extension of wireless telegraphy.

ENGOBES OR SLIPS.

ENGOBE or slip masses are composed of clay mixed with substances that impart to it, when fired, a definite color. They are poured onto the earthenware in the form of a thin paste, before firing.

Engobe, blue, on biscuit: Pottery white clay, 100 parts, frit of—

Sand	5 parts.	5 to 15 parts.
Potash	10 parts	
Sesquioxide of cobalt, R.K.O.	5 parts.	

Or:

White clay	100 parts.
Minium (red lead)	5 parts.
Smalt	40 to 50 parts.

Engobe, blue, on crude ware: (a) Porcelain clay 100 parts, by weight, fat white clay 40 to 50 parts, sesquioxide of cobalt 4 to 10 parts. (b) White clay 100 parts, quartz 40 parts, sesquioxide of cobalt, 4 to 10 parts.

Engobe, brown, for rough ware, as for red, in place of iron oxide, umber, brownstone (manganese) or oxide of manganese.

Engobe, yellow, on biscuit: White clay 100 parts, frit consisting of—

Sand	1 part.	50 parts.
Potash	2 parts.	
Naples yellow or antimony oxide	1 part.	

Engobe, yellow, on rough ware: Porcelain clay or white clay 100 parts, antimony bloom (oxide) or Naples yellow 5 to 7 parts, red lead 12 to 16 parts, peroxide of tin 2 to 5 parts (some oxide of lead).

Engobe, green, on biscuit: White clay 100 parts, frit composed of—

Sand	1 part.	20 to 30 parts.
Potash	2 parts.	
Chromic oxide	2 parts.	

Engobe, green, on rough ware: (*a*) Porcelain clay 100 parts, rich white clay 40 to 50 parts, chromic oxide 5 to 10 parts. (*b*) White clay 100, quartz 40, chromic oxide 5 to 10.

Engobe, green, on rough ware for light firing: (*a*) Porcelain clay 100, rich white clay 40 to 50 parts, oxide of copper 20 to 25 parts. (*b*) White clay 100, quartz 40 parts, oxide of copper 20 to 25 parts.

Engobe, red, on rough ware: (*a*) Red ocher 100 parts, yellow ocher 20 to 50 parts, red oxide of iron 10 to 20 parts. (*b*) Red clay 100 parts, red oxide of iron 20 to 30 parts.

Engobe, red (color under the glaze): Yellow ocher is heated to redness and mixed with white clay in the proper quantity.

Engobe, black, for rough ware: Terra di Siena 100, calcined brownstone or oxide of manganese 5 to 12 parts, iron hammer scale 5 to 6 parts, sesquioxide of cobalt 1 to 1½ parts, oxide of copper 1 to 1½ parts.

Engobe, violet, for rough ware and very light firing: White clay, also mixed with porcelain clay, 100, best calcined brownstone (manganese) or oxide of manganese 5 parts.

Engobe, violet, on biscuit: White clay 100, frit composed of—

Sand	16 parts.	50 parts.
Potash	32 parts.	
Brownstone or pyrolusite..	1 part.	

Engobe, white, on rough ware pottery: (*a*) Porcelain clay 100, rich white stoneware clay 25, dioxide of tin 5. (*b*) White clay 100, quartz 50 parts, dioxide of tin 5 parts.

Engobe for earthenware: Red: Ocher mixed with clay paste in proportion to the depth of color to be obtained. Brown: The same, with oxide of manganese, ocher, 75; English red 25, pyrolusite or brown manganese 1 part. Violet: Sand 1 part, potash 2, pyrolusite 1/16, and half of the entire mass by weight of white clay. Yellow: A frit of sand 1 part, potash 2 parts, white clay 2 parts. Blue: Smalt. Green: Mixture of the frit for yellow and smalt or oxide of copper.

RECENT PROGRESS IN PRODUCER GAS POWER INSTALLATIONS.

By GODFREY M. S. TAIT.

RECENT progress in the art of power generation has shown considerable improvement along the line of gas producers and gas engines, and one system which has recently been perfected will probably prove to be a topic of interest.

As is generally known, the producer plants for supplying gas to engines for power purposes are generally classified under two heads, namely, the suction type and the pressure type, the difference being that in the one case the draft through the fuel bed is induced, while in the other case it is forced, a pressure of several inches as measured by a U-tube water gage being supplied below the fuel.

The resulting gas from these two systems is practically the same, the suction producers being utilized for installations of a small character, where the power is only required for eight or ten hours continuously, while the larger pressure producers are usually installed where units of a larger character are desired, and it is found to operate twenty-four hours per day.

Investigations in this country and in Europe go to prove that the suction producer shows a higher economy than the pressure type, but that it is under the disadvantage that the fires cannot be cleaned while the plant is in operation without seriously changing the quality of the gas. On the other hand, the pressure type of plant, owing to the fact that the fuel bed is under pressure, can be cleaned through the water seal or otherwise, and the fire poked indiscriminately from the top through large pokeholes, without any marked effect upon the quality of the gas. However, when this poking is being done considerable gas escapes through the pokeholes, to the annoyance of the occupants of neighboring buildings.

The standard method of operating gas producers consists, as the reader is probably aware, of introducing a blast of air and steam below a fuel bed of sufficient depth, the air causing combustion in the lower layers of the fire, while the steam carried along is dissociated by the heat, the reaction being about as follows: Air plus steam (ONH_2O) coming in contact with the fuel (carbon) breaks the former up into CO_2NH_2O. This is the reaction in the first 12 inches of the fuel bed or thereabout. This gas rising through the incandescent fuel above, the first layer changes as follows:

CO_2 takes up one atom of carbon, forming 2CO, while the steam (H_2O) breaks up into its constituent parts, the oxygen combining with the carbon to form another atom of CO, while the hydrogen is liberated and remains in that form. The resulting gas from this reaction is about as follows, when analyzed as it leaves the purifying apparatus:

	Per cent.
Carbonic acid (CO_2)	5.8
Oxygen (O_2)	1.3
Carbonic oxide (CO)	19.8
Hydrogen (H_2)	15.1
Marsh gas (CH_4)	1.3
Nitrogen (N)	56.7

The total British thermal units per cubic foot of this gas as measured by a calorimeter will be found to be 136.

While this gas is ideal in point of low cost, it has been found to possess great drawbacks due to the irregularities in the component parts of same, which irregularities are influenced by the temperature of the fire, which varies with the load on the engine.

For example: When the engine is pulling a full load and the gas generator is working to its full rated capacity, the temperature in the lower zone of the fuel bed is found to be about 2,000 deg. F.; and as at this temperature practically all the steam fed below the fuel bed is dissociated to form hydrogen and carbon monoxide, the hydrogen constituent of the gas runs up to 18 per cent or higher, with a corresponding drop of the carbon monoxide constituent, due to the overheating of the fuel bed. On the other hand, when the engine is running light or at a very slight load, the temperature of the fire will be found to cool down to somewhere around 1,400 deg. F.; and as at this point the dissociation of steam is very light, being only about 15 per cent, it is natural that the gas should show, as it does, a decrease of hydrogen down to about 5 per cent in the finished gas with a corresponding increase of carbon monoxide.

This change in the constituents of the gas, however, does not show any especial change in the total British thermal units, and for this reason engine builders and producer manufacturers have been prone to disregard this feature as being of no especial importance. However, as will be seen below, a change in the quality of the gas, irrespective of its change in heat units, is more liable to give trouble in an engine than an actual drop in heating units, with an analysis the proportions of which remain the same.

The writer has experienced in the various producer plants which he has been connected with a great deal of trouble in the variations above outlined, and which resulted in back-firing, preignitions, and general irregularity of operation on the part of the engine, which in turn caused dissensions between the producer builder and engine builder as to who was at fault in the matter; the producer builder, on the one hand, claiming that as they were furnished a gas of a guaranteed number of heat units (125), the engine ought to run, and that if it did not, it was the engine's fault; while on the other hand the engine builder protested that his engine would give perfect service on illuminating or natural gas of a fixed analysis, and that the very poor

equivalent to a gas containing one active constituent, namely, carbon monoxide.

With this gas it was found necessary to advance the time of ignition considerably to take account of its slow-burning qualities, and it was also found possible to increase the compression of the engine, due to the fact that the tendency to preignite from high compression is almost *nil* with this gas.

With this gas containing only 95 British thermal units, as compared to 135 of the other, and with this same engine, a total horse-power was developed of 116 under favorable conditions, while a load of 110 could be carried twelve hours at a stretch without any difficulty. Incidentally, the efficiency of the engine ran up from 15.3 to 25.9.

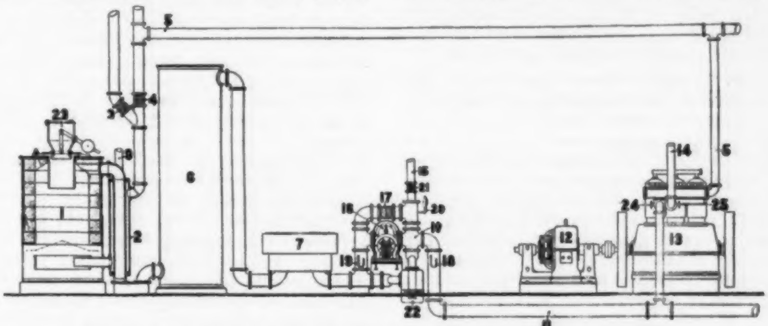
While this difference in efficiency may seem extreme, it must be borne in mind that on the one hand the producer gas, containing two constituents of widely different character, placed the engine at a great disadvantage, while on the other hand, a gas containing one active constituent gives the engine the double advantage of being able to operate under a very much higher compression pressure, with corresponding increase of efficiency, while also the fact that the charge has one fixed ignition point enables the firing of same to be done with much greater accuracy than is ever possible on a gas of mixed constituents.

One of the plants recently installed along these lines, and with a view to eliminating all possible trouble from variations in the gas, as above outlined, was erected several months ago as the sole source of power for the John Thompson Press Company in Long Island City.

In this plant the service is very exacting, being for twenty-four hours per day at loads varying from a quarter to full and even overload, there being variations of as high as 30 per cent in periods of less than a minute at frequent intervals, when large machine tools are thrown in and out of service.

A diagrammatical view of this plant is shown in illustration herewith, and referring to same, the following points will be noted:

At 1 is shown a vertical section of the suction producer employed, and it will be noted that there is no evaporator or other steam-generating apparatus shown in connection with same. Referring again to this illustration, at 23 is shown a coal-feeding hopper



PRODUCER GAS INSTALLATION IN WHICH VARIATION IN THE GAS IS AVOIDED SO FAR AS POSSIBLE.

service shown on producer gas was due to the variations in that gas. This controversy prolonged itself, to the great detriment of the business and the intense dissatisfaction of builders of producer plants, and caused the writer to investigate the matter, with a view to finding out the actual cause of the trouble and the remedy therefor.

The result of these investigations shows clearly that, first, a gas engine can be constructed to run on gas, no matter how weak (take blast-furnace gas for example) provided that the constituent parts of that gas are constant and that the total heat units do not vary under certain prescribed limits. That a gas furnished for gas engine purposes, no matter how high its thermal value, may be entirely unsuited for the purpose if the constituents vary in their proportion to each other during the operation of the plant. That a gas high in heating value furnished to a gas engine does not necessarily develop power in proportion to its heating value, unless the rate of combustion of the combustible elements is constant.

Take for example producer gas. In it we have a gas containing practically two active constituents, carbon monoxide and hydrogen, and as well known and admitted, the rates of combustion of carbon monoxide and hydrogen are about as two to one, the hydrogen being the more rapid-burning of the two.

Now it follows that in a gas-engine cylinder the time of ignition cannot be so arranged as to be accurate for two gases the duration of combustion of which are different; and as in the case of producer gas, hydrogen is the more rapid-burning of the two, the ignition has to be set to coincide with same, with the result that the carbon monoxide is ignited too late to deliver its entire power in the working cycle of the engine, the balance of heat units being absorbed by jacket water losses, etc.

To prove this point, the writer equipped an engine with a producer generating the ordinary type of gas, and was enabled to develop with it a maximum of 102 horse-power under the most favorable conditions, the engine being rated at 100 horse-power. He then disconnected all steam connections from the producer, so as to admit a draft containing only pure air, the resulting gas being necessarily carbon monoxide and nitrogen, and as nitrogen is an inert gas, this was

through which the fuel supply is fed at periods of from one and one-half to three hours, according to the load upon the plant. The gas generated passes off through downtake of producer, up through scrubber 6, from 6 through purifier 7, through exhauster 16, pipe 10 to gas main 11, from which it is distributed to the two engines, one of which is shown in 13.

The operation of this plant is as follows: A fire is built of pea coal or other anthracite fuel, in producer 1, to a sufficient depth to reach up to the bottom of magazine at bottom of hopper 23. The gas then flows through downtake and into the bottom of scrubber 6, from the top of which it flows to purifier 7 and to exhauster 16. This exhauster, which is motor-driven when the plant is running, takes the gas from the producer and delivers same under pressure to gas main 11.

In order that the pressure in gas main 11 may be at all times uniform, there is a bypass relief pipe around this exhauster in which is set a valve 17, the opening or closing of this valve controlling the amount of gas delivered to pipe 11 by exhauster 16.

When starting the plant, valve 21 on waste pipe 15 is opened, and the gas is allowed to escape to the atmosphere until such time as gas issuing from burner 20 is capable of burning with a steady blue flame, at which time engine 13 is started by compressed air, as per the usual method, and valve 21 is closed, shutting off the outlet through pipe 15. All gas supplied by exhauster 16 now goes to the engine through valve 24, and air for the engine enters through pipe 14 and is mixed at valve 25.

The exhaust of the engine goes off through pipe 5 and back toward the producer, where part of it escapes through the roof and the balance comes down through valve 4, where it mixes with the incoming air for the producer, which enters through pipe and valve 3. This mixture of air and exhaust gas then passes down through preheated jacket 2, whence it issues into the ash pit of the producer and thence to the fire.

As can readily be seen, any mixture of exhaust gas and air that is desirable can be obtained by the manipulation of valves 3 and 4, it not, however, being necessary to change these valves when the plant is once in operation.

At 22 will be seen a water-sealed bypass which admits of very close regulation on the pressure of the

gas delivered to the engines, for if the gas in pipe 11 rises above a predetermined pressure, part of same will break through water seal 22 and flow back to the intake side of the exhauster, short-circuiting same and thereby keeping a very constant pressure on the gas main.

In this plant the engines consist of two units of 125 horse-power and 50 horse-power respectively, each directly connected with rigid couplings to direct-current 240-volt generators, the current from same being used in parallel, and it being found that so close is the regulation that at all times these two engines take their proportionate part of the factory load.

This arrangement has proven very satisfactory from a power standpoint, due to the fact that either of the two engines may be used, or both together, according to the load at that time, thus keeping the machinery as close to a full load as is desired.

This plant has operated with entire success ever since its starting, there having been absolutely no trouble from back-firing, preignitions, or any other source, as the quality of the gas remains constant under all conditions and the quantity furnished to the engines in proportion to their needs.

It will be noted that the changes in this plant which have resulted in the elimination of trouble from varying quality of gas are of a very simple nature, and do not add in any way to the expense of the outfit as originally installed, it being understood, of course, that the exhauster system shown here would not be necessary when operating only one engine, it being simply an adjunct for the purpose of delivering gas under steady pressure where two or more engines are desired.

The coal consumption of this plant is about 15 per cent lower than that of the regular type suction producer using steam as a temperature reducer in the producer; but apart from this point of economy, the feature which appeals most strongly to the users of the machinery consists of the fact that the operation is in every way as reliable and the handling is even more simple than that of a steam plant of the same capacity.

It would seem that this modification to producer practice has at last placed suction producer plants upon a par with steam installation in point of reliability and ease of operation, while the undisputed economy of the gas producer is maintained and even exceeded.

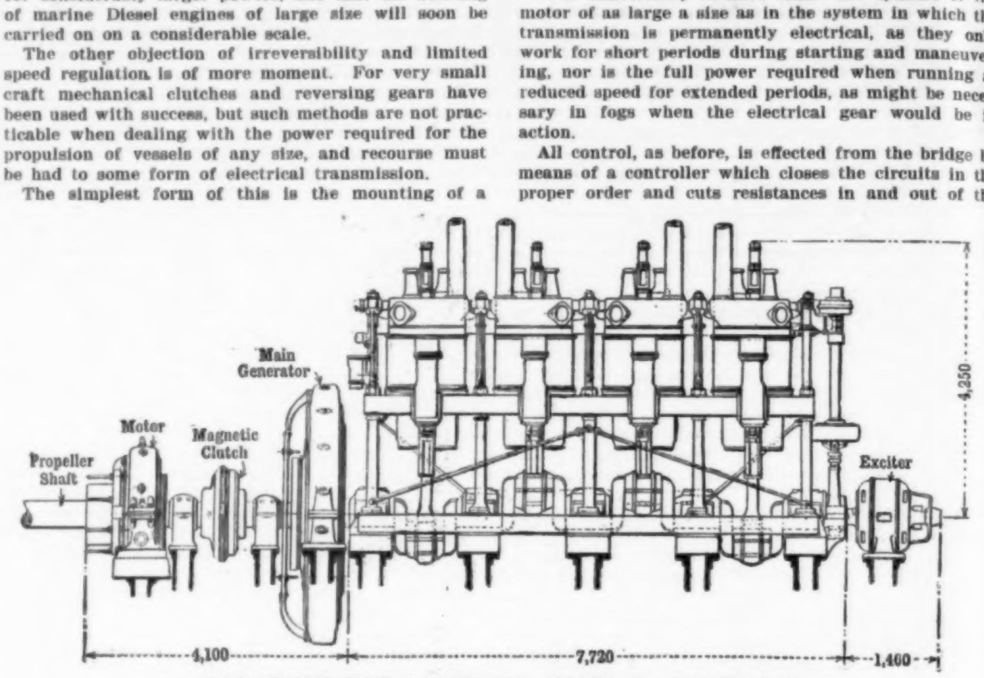
THE DEL PROPOSTO SYSTEM OF ELECTRICAL TRANSMISSION GEAR FOR THE PROPULSION OF SHIPS BY IRREVERSIBLE ENGINES.

A PAPER by M. C. Del Proposto, published in the Bulletin of the Société Belge d'Electriciens, describes an electrical method of power transmission which has been developed by the author in connection with the use of irreversible internal combustion engines for the propulsion of ships. The system is more particularly intended for application to Diesel engines, and the earlier part of the paper enlarges upon the advantages which this type of engine possesses over steam or suction gas plants for marine use, provided that a satisfactory transmission gear can be devised for starting, reversing and running at reduced speed. Not only, for the same radius of action, is the weight of fuel reduced to about two-fifths of the amount required when it takes the form of coke or coal, but it can be stowed away in the more out-of-the-way portions of the ship, making a larger portion of the space that would otherwise be occupied by bunkers available for cargo. The space required by the boilers or gas producers is also saved and the services of the stokers are dispensed with. Again, the expenses in getting liquid fuel on board are nothing approaching those of coaling, and the cost of the crude oil which is used compares favorably in most parts of the world with that of coal required for the same distance run, being, of course, most markedly cheaper near the oil-producing districts.

The principal objections to the use of internal combustion engines for marine work have hitherto been the fact that engines of this type have not up to the present been commercially manufactured in sizes large enough for the propulsion of anything but small vessels, and also difficulties in reversing and speed regulation. The author, however, points out that the Augsburg Company have already constructed Diesel engines of 1,000 brake horse-power, so that if three propeller shafts are used, each with its own engine, 3,000 brake horse-power is at once available; or with two such engines to each shaft, 6,000 brake horse-power could be obtained. This, although of course not sufficient for large liners or battleships, would suffice for cargo boats and other vessels of quite considerable size. These engines have four single-acting cylinders, each 700 millimeters diameter and 1,770 millimeters stroke, and run with a four-stroke cycle at 150 revolutions per minute. There is, however, every indication that engines of this type can be successfully constructed for considerably larger powers, and that the building of marine Diesel engines of large size will soon be carried on on a considerable scale.

The other objection of irreversibility and limited speed regulation is of more moment. For very small craft mechanical clutches and reversing gears have been used with success, but such methods are not practicable when dealing with the power required for the propulsion of vessels of any size, and recourse must be had to some form of electrical transmission.

The simplest form of this is the mounting of a dynamo on the engine shaft which is governed to run at constant speed, and using the current from this to drive an electromotor connected to the propeller shaft, some simple form of switch gear being all that is required to vary the speed and direction of motion.



1,000-HORSE-POWER DIESEL-DEL PROPOSTO EQUIPMENT.

Applications of electrical transmission for driving boats have been made at various times and in different countries. An example is found in the "Vandale," an oil tank boat of some 1,100 tons displacement, built by Nobel Brothers of St. Petersburg, in 1903, for service on the Volga and the Caspian Sea. The engine room of this boat contains three generating sets, each consisting of a three-cylinder Diesel engine running at 240 revolutions per minute, direct coupled to a continuous-current dynamo giving 87 kilowatts at 500 volts. These three dynamos supply current respectively to three motors of about 100 horse-power each, mounted on the three propeller shafts and situated in the after part of the boat. Thus each propeller motor can be controlled independently, and the three controllers are placed on the bridge. All regulation is done on the fields of the generators which are supplied by small exciter machines mounted at the opposite end of each engine shaft, the motors being always connected to the terminals of their respective dynamos. The pilot on the bridge thus directly controls the vessel himself instead of by means of orders conveyed to the staff in the engine room. Changes of speed and direction are promptly and smoothly effected, and in the case of a vessel with more than one propeller, it is easy to steer with accuracy without using the rudder by handling the controllers alone.

In a system such as that employed on the "Vandale," in which the transmission is entirely electrical, there are certain unavoidable losses which diminish the overall efficiency, and therefore increase both the size of engine required and the fuel consumption over that which would be required with a more direct method. It was mainly to obviate this disadvantage that M. Del Proposto's system was designed.

In this arrangement a dynamo is mounted as before on the engine shaft, but the propeller shaft with its motor is brought right up to the engine room and can be coupled directly to the engine, when required, by a magnetic clutch. Thus at starting, and when running at reduced speed, or in the reverse direction, the clutch is free and the electrical transmission is used in an exactly similar way as in the system previously described. When, however, the vessel is traveling forward at its normal speed the clutch is put into engagement, and the motor and dynamo simply run around unexcited, and with their brushes raised. A separate exciter, mounted at the other end of the engine shaft, is used as before for supplying the current for the magnetic clutch. A mechanical clutch can, of course, be substituted for the magnetic clutch, but the amount of energy required for its working is so small compared to the whole output of the engine as to be negligible, and, in the author's opinion, magnetic clutches are preferable on account of their simplicity.

It is unnecessary to have either the dynamo or the motor of as large a size as in the system in which the transmission is permanently electrical, as they only work for short periods during starting and maneuvering, nor is the full power required when running at reduced speed for extended periods, as might be necessary in fogs when the electrical gear would be in action.

All control, as before, is effected from the bridge by means of a controller which closes the circuits in the proper order and cuts resistances in and out of the dynamo field circuit. A lamp connected across the terminals of the exciter indicates to the officer on the bridge whether the engine is running, and a center zero voltmeter connected to the propeller motor terminals serves to indicate the speed and direction of motion of the propeller shaft.

STORAGE BATTERIES AND BATTERY PLATES.*

By GEORGE P. HUTCHINS.

THE advantages of a properly designed, properly installed storage battery appear in three distinct phases—first, mechanical, as maintaining virtually uniform loads upon generating equipment, enabling engines to be operated at the point of highest efficiency; second, electrical, as maintaining electrical pressures over long lines, despite fluctuations, and likewise as preventing electrical losses due to carrying large volumes of current over limited conductors; and third, financial, as a result of the other two gains, showing as a smaller investment and lower cost of kilowatt output.

The storage battery is to-day an important and essential part of a complete power plant.

Batteries for general power service are of three distinct types—the regulating battery, the floating or line battery (as used chiefly on street-railway lines), and the booster line battery.

The regulating battery is always installed in connection with a booster through which all current flows, both on charge and discharge. The essential function of the booster battery is to neutralize fluctuations, charging when the current demand is light, discharging when the current demand increases above a predetermined point, thus maintaining a practically uniform load upon the generating equipment. During hours of very light load the engines may be entirely shut down and the battery furnish all power required.

The line or floating battery has no booster or other charging equipment. It is simply connected across the circuit at points distant from the power house where the pressure drop under fluctuations is considerable. When the current demand is light the electromotive force of the line exceeds that of the battery, and current is absorbed. When the current demand causes the line pressure to drop below the electromotive force of the battery, discharge takes place, so that voltage fluctuations are minimized. The booster line battery as used on long lines entails the erection of a separate feeder line direct to the battery, the voltage of which is raised by a booster in the power station to any necessary extent above the line voltage to compensate for drop. This provides one auxiliary service of supply to the battery.

There are two distinct economies in line batteries—first, the saving on cost per kilowatt delivered, due to the elimination of large voltage losses on a given amount of current transmitted; second, the smaller investment in copper conductors required to transmit

FIG. 1.—FROM BLANK TO BATTERY PLATE.

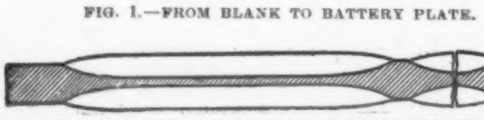


FIG. 2.—LONGITUDINAL SECTION OF FRAGMENT OF PLATE.

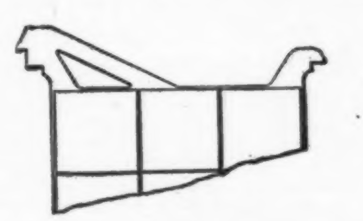


FIG. 3.—DOUBLE CONDUCTING-LUG.

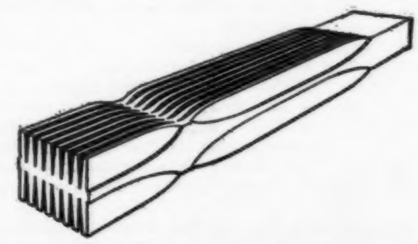


FIG. 4.—SMALL PORTION OF FINISHED BATTERY PLATE.

STORAGE BATTERY PLATES.

* Western Electrician.

the extreme ampere demand within the limits of allowable voltage drop. It is a fact too little appreciated that the first cost of a line battery is often very much less than of copper feeders sufficient to secure anything like equivalent effect. As evidence of the extent of these economies it may be stated that the line batteries installed by the Gould Storage Battery Company have frequently saved their entire cost in less than eighteen months.

The requirements of a lead storage-battery plate, as given by Lamar Lyndon, M.E., in "Storage Battery Engineering," are substantially as follows:

1. Uniform resistance throughout grid to secure even current flow through active material.
2. Allowance for expansion and contraction of active material during discharge and charge.
3. Close electrical contact between active material and support plate.
4. Freedom from local or secondary action.
5. Provision for ample circulation of acid electrolyte.
6. Large surface of active material exposed to electrolyte.

The following brief description of the Gould battery plate and the accompanying illustrations serve to explain to how great a degree this plate fulfills the theoretical requirements as set forth above.

The Gould plate is of the Planté type, so called, in which the active material, lead peroxide for the positive and spongy lead for the negative, is formed electrochemically out of the lead composing the support plate or contact surface.

Fig. 1 is a fragment of a Gould plate illustrating the manner in which the large contact surface for active material is developed out of a sheet of rolled lead cut to the size and shape of the plate. This "blank" is placed between two shafts on which are mounted sets of rapidly revolving steel disks with spacing washers. These disks are pressed against the plate and moved to and fro, working into the lead further and further and spinning the metal between the knives up into thin parallel ribs.

Fig. 2 is a longitudinal section of a fragment of a plate, and shows the web of metal left as a central conductor and also the diamond-shaped cross conductors and current-distributing bars.

Fig. 4 is a perspective drawing of a small fragment of finished plate and clearly indicates the character of the construction. The active material is formed out of the lead composing the contact surface between the ribs, filling the spaces with closely packed but highly porous active material. Expansion and contraction cannot cause loosening or falling out of the active elements, and the closest electrical contact is preserved.

Fig. 3 shows the double-conducting lug by means of which better distribution of current is secured.

Only chemically pure, densely rolled lead is used, so that secondary actions leading to "self-discharge" are impossible. The plate is absolutely integral; no lead is removed or added in making the plate—the blank is merely changed in form. There is ample provision for circulation of electrolyte and large contact surface for securing high efficiency and long life. In addition to batteries for power purposes the Gould company is manufacturing types for telephone, telegraph, and signal service, for train lighting, and for electric vehicles.

NOVEL HOUSE-MOVING OPERATIONS.*

By EDWARD H. CRUSSELL.

IN order to secure better grades when we were "double-tracking" a portion of our line a while ago some pieces of the old single track were entirely abandoned, and on one of these pieces of track stood a building that was to be moved. The distance from where it stood to the point where the old line joined the new was about $3\frac{1}{2}$ miles, and from this point it was to be brought back along the new line until it stood nearly opposite to its old location, but $1\frac{1}{4}$ miles further south.

One thing in our favor on the present job was the fact that we had the old line entirely to ourselves, as, of course, no trains were running on it. For the first half of the moving we were, therefore, not pressed for time. Besides this, as the curves in the old line were sharper and more frequent than those in the new, any mishap likely to occur would in all probability happen on it, where we would be able to cope with it without the worry and danger of delaying trains. It may be remarked for the benefit of the reader that the delaying of schedule trains is one of the worst offenses a railroad man can commit, and he does not do it often—at least not on the same railroad.

The writer has thought it would be well perhaps in the present article to go somewhat into the matter of loading long material on open cars in order to illustrate to the uninitiated some of the minor difficulties attending this method of house moving. In the first place, all material of whatever kind that is shipped in twin or triple loads—in other words, material that is too long to ship on one car—must have but two bearing places, as indicated in Figs. 1, 2, and 3. The object of this is to allow the cars to be free to adjust themselves to the curves in the track. Material loaded flat on the floors of two cars, for example, would either derail the cars by crowding them off the outside of the curve or unload itself by breaking the stakes that hold it on the cars. There is one exception to this rule of two bearing pieces, and that is in the case of long flexible material that is not stiff enough to be supported from the ends. In such an instance all bearing pieces, except the two end ones, must have two steel plates between them and the load. These plates must be well covered with heavy grease, so that they may slide easily one on the other as the cars move from side to side while the train is in motion.

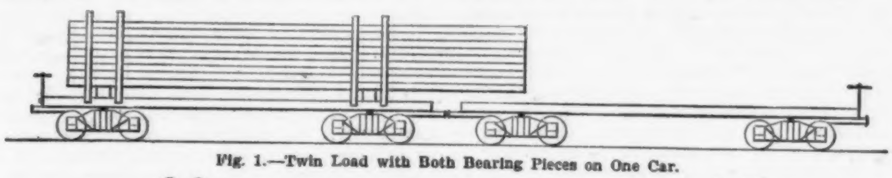


Fig. 1.—Twin Load with Both Bearing Pieces on One Car.

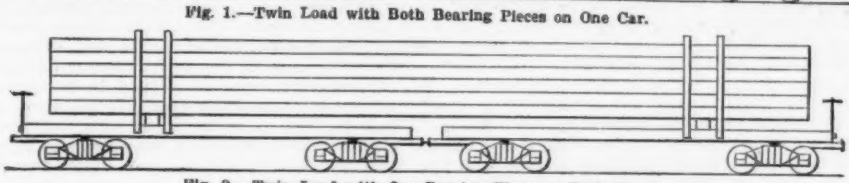


Fig. 2.—Twin Load with One Bearing Piece on Each Car.

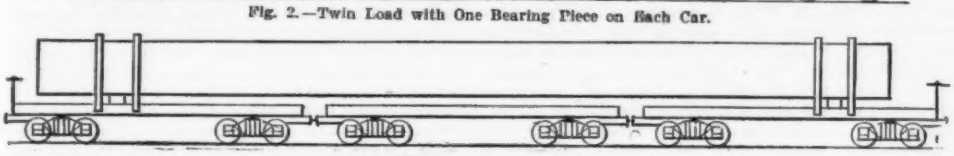


Fig. 3.—Triple Load with One "Idler."

Another important fact to be considered in connection with this class of work is the location of the bearing pieces on the cars, the proper position for which is midway between the center of the car and the center of the truck. Only one-half of the marked capacity of a car may be loaded, and in no case must the bearing piece be placed beyond the center of the truck toward the end of the car. Nearly all buildings are heavy enough to call for the "three-fourths capacity" position, but it is not always easy to divide them up so as to be able to place the timbers there. After all the cars for one load have been coupled together they must be jacked apart and have blocks fitted in between them, so as to take up all the slack in the springs of the couplers and prevent the cars sliding back and forth under their load. The cars must also be chained together to prevent them from pulling apart, supposing the couplers should fail while the cars are under way. Cars loaded as indicated in Fig. 1 need not be chained, but if one of the bearing pieces shown rested on the second car it would then be necessary to chain them.

Enough has probably now been said on the subject to show that there are many things to be considered, but before we start to load our building and having finished with them we will go back to the starting point and see how the loading is to be done.

The first work necessary in nearly all cases is the putting in of good, substantial sills. The method of doing this varies with local conditions, but generally the floor joists are supported on jacks and timbers just back of the old sills, which are then taken out one at a time and replaced with new ones. If the building is high enough to do it we place the carrying timbers under a jack and crib from under them until the structure is high enough for loading. If it is too close to the ground to get these timbers in place it must be jacked from under the sills until there is sufficient room. We use for cribbing sawn cedar railroad ties whenever we can get them, and in nearly all cases we use 10-inch by 10-inch by 28-foot Georgia pine for the sills. Of this last material we always have a quantity in stock, as it is our standard double-track bridge tie.

The use of so stout a timber for sills enables us to use hydraulic jacks for raising the building, as these are quicker and easier to work than screw jacks. It also assists us materially in the spacing of the bearing

Fig. 6.—The Building in Its New Position.

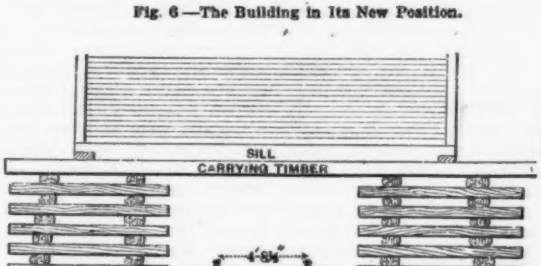


Fig. 4.—End View of Cribbing and Lower Portion of the Building, Showing Latter Ready for Loading.

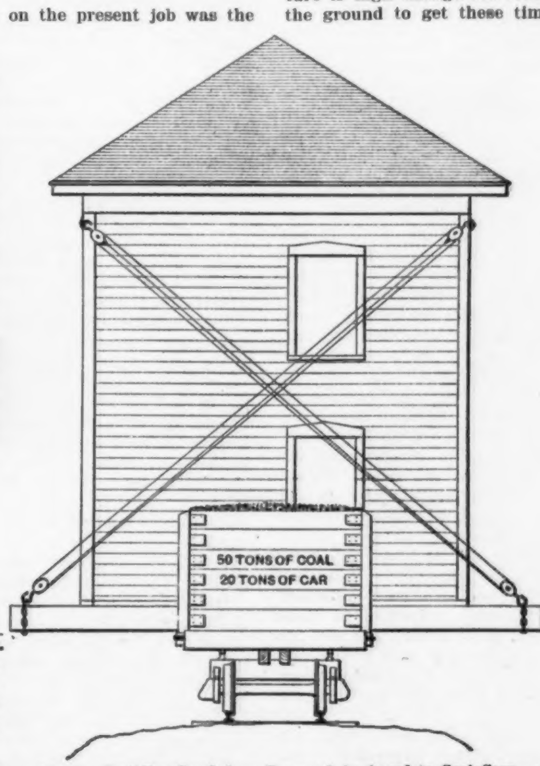


Fig. 5.—Building Loaded on Cars and Anchored to Coal Cars.—Scale, ⅛ In. to the Foot.

NOVEL HOUSE-MOVING OPERATIONS.

* Carpentry and Building.

pieces, as, of course, it will permit of a longer span than would a smaller sill.

In the case of the piece of work under consideration it may be stated that the land where the building stood was considerably lower than the surface of the track, and to have raised the building there to the proper height for loading would have required a cribbing at least 9 feet high. However, as the track was not in use we drew the building over first and raised it afterward, leaving the cribbing clear so that the cars could be run under and the building lowered onto them. In Fig. 4 is an end view of the cribbing and the lower portion of the building, showing the structure ready for loading and before the cars were placed under it.

It was necessary to use four carrying timbers or bearing pieces for this building, the two center ones being provided with steel plates, as mentioned in connection with flexible material, and this, coupled with the comparatively slow rate of speed at which we moved, was sufficient for the purpose.

Our greatest difficulty was to keep the building balanced. The standard railroad track gage is only 4 feet 8½ inches, and the ball or top of the rail is 2¼ inches wide, so that at the very outside measurement we had only 5 feet 1 inches as a wheel base. With the bearing pieces on the cars the sill of the building was nearly 5 feet from the rail, the walls were 20 feet to the eaves, and, as before stated, the building was 19 feet wide. When we consider that some of the curves in the old line had as much as 3 inches elevation, it is evident that something had to be done to prevent the building toppling over into the fields. After several schemes had been proposed and abandoned it was finally decided to anchor each end of the building to a loaded coal car. For this purpose 8 x 14-inch timber outriggers were fastened to the ends of the cars, extending a short distance beyond the width of the building, and from the ends of these outriggers a threefold tackle was taken across and made fast to the upper opposite corner of the building. Plates of iron with rings in them were bolted to the corners of the building, and the upper blocks of the tackles were hooked into the rings, the lower blocks being fastened to the outriggers with chains.

Our standard coal cars have a capacity of 50 tons of coal and weigh about 20 tons themselves, so before this building could fall over it had to lift a weight of 140 tons. In practice we were glad to find that this was more than sufficient for our purpose. In Fig. 5 is an end elevation of the cars and building clearly showing the arrangement which we adopted.

An accurate record of the time required for executing the work was not taken, for, as before mentioned, we had all the time we wanted on the old track, but as near as can be remembered, we were about 3½ hours on the new track. Of course we had the rollers to put under this time before we could move the building off the cars. The picture in Fig. 6 is from a photograph of the building in its new location and as it appears at the present time.

SOME RECENT DEVELOPMENTS IN PLANT GROWING.*

By G. Clarke Nuttall.

There is an element of uncanniness about some of the recent developments in plant-growing. The honorable profession of gardening, coeval, we are led to believe, with man's own origin, is being lured down strange by-paths in these latter days, straying far from Nature's obvious course that has sufficed it for so many ages, and it is difficult to see yet the precise bourne at which it will arrive. All through the centuries, till now, man has been content to rear his plant children out of Mother Earth, trusting to pure water and fresh sunshine to ensure their healthy development; the ordinary routine of day and night, and the natural course of the seasons, summer and winter, seed-time and harvest, have been their share, and he has been satisfied with the offspring that have resulted from this upbringing. But nowadays the adventurous impulse of the times is leading him to experiment in many various ways, and in the spirit of many a modern ardent educationist he is bringing all sorts of previously unheard of influences to bear—electric force, electric light, colored lights, germ inoculation, anæsthetics, and what not—in the hope of raising a product superior to anything that has gone before. The days of experiment are yet too young for any of the most modern developments of plant growing to have become an integral part of horticulture; and gardeners of all men, with a fixed routine ingrained in them through countless centuries, move slowly and are apt to regard innovations very dubiously. Still a considerable measure of success, that argues a probable future, has been accorded to some of them, and they claim a definite place in our notice.

For instance, electricity, that great force which the latter part of the nineteenth century harnessed to the uses of man, has not, in its victorious career, left untouched the domain of the plants, and now electroculture, or the application of the electric current in plant-growing, is fast becoming a recognized development in up-to-date agriculture and horticulture. To Prof. S. Lemstrom, of Helsingfors University, we owe much of our knowledge in this matter, for he has been experimenting for a considerable number of years on the effect of passing a current of electricity through growing plants, and he has come to the conclusion that in the large majority of cases, crops grown in an electrified atmosphere are far above the average both in quality and quantity. During the years 1902-1903 he had experimental fields in England near Newcastle in connection with the Durham College of Science, in Germany near Breslau, and in Sweden at Alvidaberg, where he grew many plants under electrical treatment. The results were very remarkable. Thus strawberries in electrified fields showed an increase of 50 per cent to 128 per cent over those grown in normal fields. Corn showed an increase of 35 per cent to 40 per cent; potatoes 20 per cent, beets 26 per cent, and so on. And since in many of these cases the treatment was tentative and varied for experimental purposes the results will be largely improved when only the most satisfactory method is employed. In fact, Prof. Lemstrom believes that under this treatment one may safely reckon upon an average increase of 45 per cent over the normal for all crops grown on land of ordinary fertility. It is worth noticing that electricity is of no use on poor land, and it will not help poor farming. Just as "to him that hath to him shall be given," so it is on fertile and well-cultivated land that the greatest increase is shown under electroculture.

The method of applying electricity is as follows. A wire net is first stretched across the field a little above the surface; this net is then connected with an electrical machine stationed in a shed or building without the field, and the current traverses the net. As the seeds sprout and the little plants begin to grow, the net must be raised, as on no account must it touch the plants; but the raising need only be done once or twice during the summer. On rainy days it is quite useless to apply the electric current, as through the damp the wire net loses its electrical charge directly. It is also injurious to the crops to have the machine working during brilliant sunshine.

Now, when we come to inquire why the electric influence should cause so marked an improvement in the crops, we are on somewhat difficult ground. But it can probably be accounted for in two ways. In the first place the positive current passing from the points of the wire net to the earth causes the production of ozone and nitric compounds which are beneficial to the plant. In the second place the negative electricity passing up from the earth to the points of the net tends to draw up with it through the plant the sap from the root, and thus the increased circulation of the juices gives increased energy of growth. Of course, in the application of electricity, as in the use of all good things, there must be moderation, and individual plants require individual treatment as to the exact strength that is best for them.

But in all matters such as this the mundane and first question asked by a practical farmer is, "Will it pay?" Or will the cost of the apparatus swamp the increased profits? For the commercial aspect is perforce the one that appeals to him most. To this inquiry Prof. Lemstrom asserts that he can give a most satisfactory answer—it will pay. Thus take the case of wheat, for example, and suppose a hectare (24.7 acres) is put under electroculture. The initial cost of setting up the apparatus he estimates at about £108, the annual upkeep at £23. Now, reckoning wheat as giving 34 bushels to the acre, an increase of 45 per cent due to the electric current will give an increase of 383 bushels for the field, and 383 bushels at 3s. 6d. give £67 profit. Deducting for the upkeep of the machine we have a net profit of £44 for that one field, or more than four-tenths of the whole cost realized in the first year. The larger the area worked the greater the profit, since the cost of working does not increase in the same ratio.

It is interesting to learn that Prof. Lemstrom was led to take up this line of research through his voyages to the Polar regions. He saw there that the plants showed a rapid development far surpassing that of plants in more southern climes; he saw, too, great differences in the size of wood rings in different years, and he noted the pointed needle leaves of the pines and the spikey beards of the corn. Then, with the keen eye of the man of science, he realized that the largest rings in the wood and the greatest harvest occurred in the years when there were more sunspots, when the aurora played more vividly, when, in fact, the air was largely charged with the electric fluid, and he comprehended the reason of the spikes, leaves, and beards. And from this vantage ground he was led through years of study to the conclusion that electricity must be numbered among the principal factors in plant life, a factor that, up to the present, has been practically overlooked, but which, nevertheless, plays a most important, though subtle, part in it.

Other workers, both French and English, confirm the above, and in some respects amplify it. Thus Dr. Cook found that if he electrified seeds he not only produced more successful plants from them, but a greater percentage germinated. It is as though life in some of them was flickering but faintly, and would have gone out altogether had not the electric stimulus fanned it into flame.

French men of science working at electroculture have been largely devoting their energies to trying to utilize the electricity of the atmosphere. If this could be done a practically unlimited source at nominal expense could be obtained. And their experiments show that the idea is feasible. For instance, by setting up a geomagnetifere—practically a lightning conductor—in the center of a field, and connecting it with a network of wires running through the soil of the field, an increase of 50 per cent was secured in a potato crop, while an even greater percentage of improvement showed in tomatoes, peas, and other plants experimented upon. In fact, we may conclude that on all counts electricity stimulates growth and development in the plant world, and that electroculture has an undoubted future before it.

But electricity provides yet another means of jogging Nature's arm, though in this case it is not the direct action of the force, but its power as an illuminant, on which is based a second important and recent development in plant growing. As long ago as 1881 Sir W. Siemens experimented upon plants with electric light, but the light was costly, and the matter fell through for some years. But at the end of last century the question was taken up again in both America and France, and most interesting possibilities were disclosed. The American experiments simply arranged for a number of plants to be kept in cool glasshouses and the electric light to be turned on for some hours, brilliantly illuminating them when night fell, and thus shortening the time of darkness, but not abolishing it altogether. In neighboring cool glasshouses similar plants were grown under normal conditions of day and night. The result was that the plants with the longer period of light throve better and developed earlier than the others. Lettuces, radishes, beet, and spinach all improved, but the lettuces in particular. A few plants, such as cauliflowers, like some people who cannot do with their hours of sleep curtailed, did not come up to the standard, but they were in a small minority. Violets, daisies, and other flowers bloomed more freely and better, though they, in common with other plants, are apt to feel the reaction and be more exhausted than the normal, just as a man feels additional fatigue after a spurt of hard work. Still, this eventual exhaustion of a plant is a matter of minor consideration to a florist if he can get his blooms earlier on the market, and larger and more richly colored into the bargain. And therein comes another peculiarity and virtue of the electric light stimulus; it leads to increased brilliancy of color both as to the green of the leaves and the hue of the flowers, and this discovery suggests another line of development in plant-growing which has yet to be worked out.

The French experimenters were not satisfied with treating the plants under consideration to a few hours of electric lighting. They went the whole length and left them no rest. Even the change to sunlight was denied them. Day and night unceasingly they were exposed to the full glare of the electric arc. In fact, one may compare the American treatment to the case of a man who takes alcohol occasionally in moderation, the French treatment to a man who uses alcohol as his sole nourishment, for the results are analogous. In the American method and the moderate man the stimulant is effective and not evil; in the French method and the intemperate man the outcome is stunting, disfigurement, and degradation. After some six months' continuous subjecting to the light, a common pea had a fat, twisted stem with tiny, undeveloped leaves, and other plants showed similar abortions. The green color was, however, emphasized. Everything was intensely green, thus carrying the heightening of hues a stage further from the brightness observed under the moderate electric light treatment. All this, too, is comparable to the brilliance of tints under an Arctic summer, when the days are very long and the nights are very short. And this possibility of a development of intensity of color is a line of research that might easily be taken up by many well-to-do amateurs who, in these days, have electrically lighted conservatories in their houses.

A third development in recent plant-growing is known as radioculture, and is curious and somewhat sensational. It consists in growing plants in differently colored glasshouses; that is to say, instead of the glass being clear white as is usual in greenhouses, in one case it is red, in another green, and in yet another it is blue, care being taken that in every case the color of the glass is absolutely pure. A series of experiments on these lines was first conducted by the eminent French astronomer, M. Camille Flammarion, and they proved very suggestive. He took a number of the seedlings of the Sensitive Plant (*Mimosa pudica*) (choosing this plant because of its peculiar sensitiveness), and divided them into four similar groups; one group he placed in an ordinary greenhouse, a second he placed in a blue house, a third in a green house, and a fourth in a red house. Then giving to each the same care and attention, and arranging that the intensity of the light should be the same in each case, he awaited eventualities. At the end of a few months he made an exact comparison between them, and found striking differences. In the blue house the little plants were practically just as he had put them in; they were alive and well, but they had not grown or produced new foliage or development in any way. Like the Sleeping Beauty in her castle they had seemingly fallen asleep on the day they went into blueness, and remained unchanged as in a trance. In the green glasshouse the seedlings had certainly shown considerable energy in growing, more so than their contemporaries in the ordinary glasshouse, but, on the other hand, their growth was not really satisfactory, for, though tall, they were inclined to be weedy and poor. But in the red house there were wonderful happenings. The seedlings had become positive giants, and well-nourished and well-developed ones, too. They were fifteen times as big as their sleeping fellows in the blue house, and four times as big as the normal control plants. Moreover, they had produced little round flower balls, which none of the others had even attempted; but, more remarkable still, their sensitiveness had increased to an amazing extent. It is well known that if the sensitive plant is shaken or touched all its leaves immediately fold up and their stalks droop, and it is only by degrees and slowly that it recovers from

* Fortnightly Review.

the shock. Now in the red light the plants had become hypersensitive; in fact, one might almost say quite neurotic; at the slightest breath of air their leaves shrank together and hurriedly drooped. Obviously the red light had in every way stimulated their development to an abnormal extent. They were in the greatest possible contrast to the "blue" mimosa, for these had absolutely no feeling at all, and no amount of touching or jarring could prevail on them to respond. Indeed, in every way their life had been deadened.

Encouraged by these results, other plants were afterward experimented upon, such as oaks, lettuces, and crassulas, and many additional points of interest brought out. Thus, while little oak trees (they were several years old) produced but few leaves in the blue house, their leaves did not fall in the autumn as did the numerous well-developed leaves in the red house, where branches as well as foliage had been added during the summer of experiment. Blue light, therefore, retards the processes of decay as well as those of development. In the matter of brilliant colorings, both as to leaves and flowers, it was found that colored light of any sort tended to its elimination; pure white light is necessary for the production of these tints in plants.

Radioculture has not yet been taken up to any extent for practical purposes by florists and gardeners, who are hanging back for further assurance of its value. But it is obvious that there are definite possibilities in it. One would imagine that a red house would become in time an indispensable adjunct to a florist's garden for forcing purposes, and in any event such a powerful stimulant to plant life as red light cannot be long overlooked. A blue greenhouse suggests itself as a place where plants, perhaps at the height of their beauty, could be kept for a time, at any rate, in a quiescent condition, to re-emerge on special occasions to the advantage of the florist and the delight of his customers, for delay of decay may be as valuable an asset in practical gardening as premature development.

When we come to look into the fourth line of development marked out by this recent research into the factors that affect plant life, we find that it is altogether different to the three already described. It trenches on a field of knowledge in which, in the last few years, immense explorations have been made—the great field of bacteriology; and though, in some respects, it has met with practical difficulties that have checked its progress for the moment, yet it holds within its confines great potentialities. It maintains that it is possible to improve certain crops under certain conditions by inoculating the soil or the seeds with suitable preparations of bacteria. Now it is well known that leguminous crops, such as peas, beans, and so forth, valuable in themselves, have a further special value in that instead of impoverishing the soil in which they grow, they absolutely tend to enrich it. All other crops but these take nitrogenous matter out of the ground in their growth, and hence subsequent manuring with expensive nitrogenous manure is essential if the soil is to be kept up to the standard quality. Why leguminous crops acted differently was a mystery until Prof. Hellriegel, of Germany, came forward with an explanation. He showed that the curious little nodules which usually plentifully besprinkle the roots of peas, beans, and so forth, are really the homes of colonies of bacteria, and these bacteria can do what no ordinary green plants can do: they can absorb raw nitrogen from the air and work it up into various complex compounds necessary for plant life. These compounds they pass on to their hosts, so that it is clear that they richly pay for the shelter that is afforded them in the root nodules. But if by any chance the roots of leguminous plants are badly, or not at all, furnished with the nodules, then their crops are no kinder to the soil than their neighbors', and despoil the earth instead of enriching it. Therefore it was suggested by Dr. Nobbe, of Saxony, that where we find poor leguminous crops in all probability the reason is because the soil is poor in the bacteria with which they desire an alliance. To test his point he took some soil in which plants with many root nodules had been growing, and which soil he inferred to be rich in these bacteria, and he spread it very thinly over poor soil where similar crops had been a failure. Rain intermingled the two soils, and then he resowed leguminous seeds. The results fully justified his expectations—the new crop was far superior to the previous ones, and the nodules—the bacterial homes—were far more numerous on the roots. Thus encouraged, he prepared cultures of these bacteria, whereby, in the form of a powder, he was able to compress myriads of these organisms into a bottle, for obviously the actual cartage of soil, possibly over long distances, would be a very serious obstacle to any practical utilization of his discovery. This bacterial powder he called Nitragin, and it could be used in two ways. In the first, known as soil inoculation, it was moistened with water and poured over loose soil, which soil was then spread over the desired field and deeply harrowed in, and the seed then sown. In the second, known as seed inoculation, the moistened Nitragin is sprinkled directly over the seeds, which are rolled in sand or loam and sown at once. Here, directly they germinate, they find the desirable partner, the bacterium, ready to take up its abode in the root tissues, greatly to the benefit of both. The second system seems in practice to prove the better of the two.*

The question was taken up in Canada at the State Experimental Farm, and many experiments made in very poor soil, with the result that the Nitragin-treated seeds in every case produced much finer crops than those which were not inoculated. Peas, beans, clovers, all confirmed this verdict, so the value of Dr. Nobbe's inferences is established. The fact that Nitragin in itself still requires further research to render it a commercial success—it will not keep long, and is too sensitive to its environment in the matter of heat and light—in no way detracts from the great principles involved. We know now that in certain respects there is interdependence between plants and bacteria, just as between animals and bacteria, and that it is possible to inoculate one as the other and influence the after career. We have discovered, too, that we can manipulate these bacteria and introduce them to the plants as we wish. And this knowledge opens up a new country where the vista is indeed wide and the limits to which are beyond our ken. Why should one set of plants have learned to make this alliance, and through it tap the vast sources of atmospheric nitrogen, and not all, and could we not now teach others to do it also? And what economic results might not follow? We must look to the future to solve these problems.

The last development of modern plant growing that it is proposed to treat of here is also the most recent, and it, in its turn, differs from the preceding ones we have discussed. It consists in forcing plants by the use of anæsthetics, a truly remarkable procedure first put forward by Dr. Johannsen, of Copenhagen, at the beginning of this century, and since then amplified by other botanists, particularly French ones. The plants to be treated are placed in a very dry state on a bed of dry sand in a box capable of being hermetically sealed. Under the cover of the box is suspended a small vessel into which ether is poured through a hole at the top, which hole is immediately closed. As the ether evaporates the heavy vapor descends to the bottom of the box and envelops the plants lying there. After some forty-eight hours the plants are taken out and placed in a cool house and treated as usual. The result is that the buds and flowers at once begin to sprout far more rapidly than those of unanæsthetized plants do, and are finer than usual. Thus, after being etherized, lilacs had abundant flowers and leaves, and were quite decorative plants in thirteen days, while lilacs under normal treatment only had a few flowers and no leaves at all at the end of seventeen days. Azaleas, lilies-of-the-valley, deutzias, spirea, and other plants experimented on all showed wonderful powers of early development after being under the influence of ether. One of the leading German horticulturists, hearing of Dr. Johannsen's experiment, went specially to Denmark to see them, and his verdict was "I am now convinced that your discovery for the forcing of flowers and shrubs is one of great importance to practical floriculture."

Besides the earlier production of flowers—no small financial benefit to a florist—its advantages are a saving in the fuel hitherto required for their production, and a saving of labor, since the plants are not so long in hand. There is, however, a very real danger to be guarded against, for the vapor of ether is highly inflammable, and a lighted cigar or the too close proximity of a heating apparatus would be attended with great disaster.

As to the explanations offered for the beneficial results of anæsthetics (chloroform as well as ether can be used, though it is not quite so valuable in its action), none seems absolutely satisfactory. In fact, the whole method of treatment must be considered as largely empirical up to the present. Dr. Johannsen himself considers that it has to do with the question of repose in plants, a question as yet little studied by men of science. It renders the vital powers latent, and makes repose and sleep far deeper, and recovery from them more easy and rapid. Hence the deep repose due to the drugs means greater energy of growth on recovery.

Another explanation is that anæsthetic vapors have great drying powers over the plant tissues, and tend to coagulate the protoplasm and the food reserves stored in the stem, especially at the base of the buds, and this acts as a stimulant to growth directly the plants are in the fresh air again and experience warmth and moisture. If this be so, then, perhaps quicklime, or some other drying agent, might be placed in the box instead of ether, but this has yet to be proved.

But, in truth, the five lines of development that have been here indicated—whether it be electroculture, electric light culture, radioculture, inoculation, or anæsthetization—are all more or less in the experimental stage still. All have proved their value up to a certain point, a point higher in some than in others; all are certainly worthy of further attention, and their advantages cannot be ignored. But none has yet arrived at a complete commercial success—even electroculture is not fully accepted—and at this success they all aim, and from their very nature this must be the crucial test of their practical value to mankind.

But even if the commercial value is proved to be *nil* in any or all of them, even then there is gain in the knowledge of them, for it shows that Nature is not so simple as she appears on the surface. Sunlight and sun warmth, water and earth, are not her last word after all, and depths lie beneath which only analyses like these reveal to our eyes. A plant is a product of a vast complexity of forces, a complexity unrealized until we begin to piece out one by one the many single threads that make up the web. There is nothing really new in these developments; we are only unraveling the threads. Is not cold an anæsthetic, and the white light of the sun a product of the fusion of seven colored lights? The microbes in air and water and earth have been working for myriads of years, even though we knew it not, and the electric currents through the earth have been influencing the plant world since creation. Yet the revelation of them to us is some advance toward that perfect comprehension of our world which is our ideal.

Even in reviewing them other questions rush upon us and suggest a further step in knowledge. What effect would a continuous course of any of these lines of treatment have upon plant progeny? Would the species improve under them or would it tend to deteriorate? Would electroculture and red light culture, for instance, not only stimulate the plants in the present, but their offspring in addition, or would the stimulus tend to exhaust the plant energy and lead to ultimate weakness? Are electric light and anæsthetics mere forcing agents, or can they be used to improve the race? The answers to these questions have yet to be given, and our prophecies as to what they will be must be guarded by remembering that Nature is apt to turn back upon those who too rashly force her, and whose interference upsets the balance that the experience of ages has so carefully adjusted.

* Nitragin has not been completely successful, chiefly because the culture was fed on nitrogen salts so that they were unable to fix the atmospheric nitrogen. American cultures of Dr. Moore have been more successful, because they depend almost entirely on atmospheric nitrogen for food.—ED. SCIENTIFIC AMERICAN SUPPLEMENT.

OUR MOST DESTRUCTIVE RODENT.

THE United States Department of Agriculture will soon issue a Farmers' Bulletin, prepared, under the supervision of the Chief of the Bureau of Biological Survey, by D. E. Lantz, Assistant Biologist. The topic, "Methods of Destroying Rats," is of perennial interest, and an infallible method of exterminating these rodents would be worth more to the people of the United States in a single decade than the Department of Agriculture has cost since its establishment.

One rat is much like another so far as destructiveness goes, but it is of interest to note that three kinds have appeared in this country, all immigrants from the Old World. The black rat was the first to reach our shores, which it did nearly three hundred years ago. The common species, known as the brown, or Norway, rat, arrived about the year 1775, and at once proceeded to drive out its weaker rival, until almost everywhere it has supplanted it. The third species, known as the roof, or Alexandrine, rat of Egypt, is a great mariner and infests every ship; hence, naturally, it is common along our coast, especially in the South.

All rats are dangerous foes, but the brown rat is the worst mammalian pest in existence and in the United States destroys more property than all other noxious animals combined. No statistics of the actual damage annually done by these rodents have been gathered in America. In Denmark the loss is put at $3,000,000 a year, and in France the damage by both rats and mice has been estimated at $40,000,000 annually. A single rat will consume about two ounces of wheat or corn a day, and it destroys far more of the latter than it eats, as indeed it does of most other food. The average cost to the country of feeding a rat on grain is about fifty cents a year. If for each cow, horse, sheep, and hog on the farms of the United States the farmers support one rat on grain, the toll levied on the cereals by these rodents would reach the enormous total of $100,000,000 a year. Even granting that half their food is waste material, the tax of feeding rats is still an enormous drain on the profits of agriculture.

But much of their food is more expensive than grain, and the actual losses due to these animals are by no means confined to food. They enter stores and warehouses and destroy dry goods—lace curtains, carpets, woolens, silks—as well as kid gloves and other leather goods. They gnaw through lead pipes, flooding buildings with water or filling them with gas. They injure furniture and the foundations and doors of buildings. They eat the insulation from electric wires, thus causing disastrous fires. The average fire loss in the United States due to defective insulation is placed at $15,000,000 annually, a considerable part of which is said to be caused by rats.

Rats destroy eggs and young poultry, pigeons, game birds, and wild song birds. They have been known to kill young rabbits, pigs, and lambs, and even to attack children. Carl Hagenbeck once lost three young elephants because rats gnawed their feet, inflicting incurable wounds.

In addition to the direct damage they do, rats are known to be active agents in carrying disease germs from house to house and from city to city. Bubonic plague is usually disseminated from port to port in this way.

Their prolificness is the chief obstacle to their extermination. They produce young from three to six times a year, and females breed when about three months old. The average litter is about ten, but often it numbers fourteen or more. If three litters of ten each are produced every year, a single pair, breeding without check and without losses by death, in three years would be represented by ten generations and would number 20,155,392 individuals. The eleventh generation, due at the beginning of the fourth year, would number over a hundred millions.

The world has been fighting rats for several centuries, but the warfare has been neither systematic nor persistent. The number of "infallible" devices and formulas for killing the rodents that have been put forth would fill volumes, and still the pestiferous rat survives and grows more and more cunning as the devices for its destruction gain in ingenuity.

The Biological Survey does not pretend to have

worked out an infallible device for killing rats by wholesale, but the methods for their destruction given in the bulletin are those which careful experimenters have shown to be the best, and the formulas for poisoning and trapping are the most approved ones. Particular emphasis is placed on the rat-proof construction of buildings and on organized co-operative efforts to destroy the animals.

FIG. 1.—CYLINDRICAL COOLER.

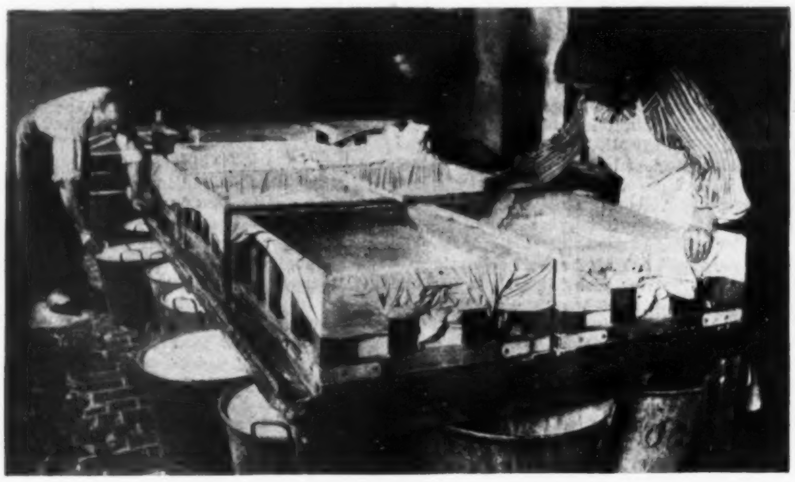


FIG. 2.—COAGULATION OF THE MILK.

HOW SOFT FRENCH CHEESES ARE MADE.*

By Jacques Boyer.

Probably as much cheese is made in France as in any other country, and French cheese makers have succeeded in producing many varieties of this article of diet, as a result of competition and the endeavor to meet the varying tastes of their fastidious customers, who hold, with Brillat-Savarin, that "a dinner without cheese is like a beautiful woman with only one eye." In this article we shall confine our attention to the principal soft cheeses which are marketed either in the fresh state or after undergoing the process of fermentation which is known as "ripening."

In order to obtain so many sorts of cheese from the same raw material—whole or partly skimmed milk—it is necessary to subject the milk to various treatments, differing in the temperature at which the curd is formed and the methods of shaping and ripening. Suppose, then, that we visit an up-to-date cheese factory and see what is done there.

Usually the factory collects milk from the surrounding country, either sending for it to the farms two or three times a day or receiving it from the dairymen, who bring it to the factory in tin cans containing about twenty quarts each. In summer, the milk is cooled immediately after its arrival at the factory, as the microbes which spoil milk do not thrive at low temperatures. The simplest method of cooling consists in setting the cans in a tank of cold water, but special refrigerating devices are employed in large factories. These coolers, which are of various forms, are so arranged that the milk flows downward over the outside, while a current of cold water moves in the opposite direction inside of the thin wall. The cylindrical cooler, shown in Fig. 1, has a spirally corrugated surface of tinned copper and the water flows between this and an inner smooth cylinder of sheet iron.

As the milk leaves the cooler it is caught in vessels which are emptied into a great mixing vat in order to secure uniformity of the raw material.

If the so-called "Swiss" or double cream cheese is to be made, cream is added to the milk in proportions varying from one-sixth to one-third of the total volume. The milk and cream having been thoroughly mixed in a tinned iron vessel the curd is formed at a temperature of 59 or 61 deg. F., by the addition of rennet, a substance obtained from the fourth stomach of young calves (Fig. 2). For double cream cheese the rennet is diluted with water and the formation of the curd occupies about twenty hours. In consequence of the slowness of coagulation the curd is very rich and creamy. Very little rennet is required—about one part to 10,000 parts of milk.

FIG. 4.—KNEADING THE MASS WITH A ROLLER-KNEADING MACHINE.

When the coagulation is complete men lift the curd with large tin ladles and lay it on cloths, which are then folded so that they resemble oddly shaped pillows, laid in a row on a draining table and covered with a board on which large iron weights are placed in order to press out the whey (Fig. 3). This draining process usually occupies fifteen hours. The cloths, or bags, are then laid on a table and opened and the curd is removed with small wooden scrapers.

To give the paste the desired consistence, it is next kneaded, either with the hands, or (with the addition of a little cream) in machines with smooth rollers, one of which is shown in operation in Fig. 4. The kneaded mass is collected in vessels lined with cloth and paraffined paper, allowed to dry for a time and then molded into the desired form. The mold (Fig. 5) is composed of a number of small cylinders of tin, open at both ends, and soldered to a tin plate. The mold being set in a perforated board, the molder lines the cylinders with strips of paper, presses the mass into their open mouths and then lifts the mold, leaving the little cheeses, wrapped in paper, on the board. After they have been drained sufficiently they are packed and shipped. "Swiss" cheeses made in this particular manner are called "Gervais" cheeses from the name of the manufacturer who first made them at Ferrières-Gournay in the department of the lower Seine.

"Bondons," "Malakoffs," and "Petits-Carrés" (little squares) are other varieties of "Swiss" cheese, produced by a similar process, but of harder texture due to the greater pressure to which the curd is subjected.

But these double cream cheeses, which are sold chiefly in summer and contain a large proportion of fatty matter, soon become rancid. They may be preserved by applying two per cent of salt, with the hand or salt shaker. There are also "half salt" cheeses (Fig. 10), which keep and ship well. Whatever the quantity, the salt should be perfectly dry in order that it may be distributed as uniformly as possible.

A great deal of attention is now given in French commercial dairies to the manufacture of "ripened" cheeses with superficial molds. The most popular sort is "Brie," which has long been in high favor with all classes of consumers.

FIG. 3.—REMOVING THE WHEY FROM THE CURD BY PRESSURE.

HOW SOFT FRENCH CHEESES ARE MADE.

As long ago as 1407, Charles d'Orleans used to present his friends with Brie cheeses, and at the end of the sixteenth century, according to the chroniclers, Henri IV. relieved the tedium of the siege of Paris with this "royal cheese," of which he was especially fond.

The manufacture of Brie cheese comprises six oper-

* From American Homes and Gardens. Published by Munn & Co.

ations: renneting, shaking, draining, salting, drying, and ripening.

As curd is made only once a day it is usually necessary to heat the milk in wooden or copper vats, with steam pipes, to a temperature of from 91 to 106 deg. F. The milk is then siphoned into tinned iron troughs for curdling; sometimes the farmers add 10 per cent of skimmed milk from the preceding milking. This addition facilitates draining and consequently increases the hardness of the curd, and it also favors the growth of the superficial mold. Three teaspoonfuls of rennet suffice to coagulate five hundred quarts of milk in two hours.

FIG. 5.—COMPOUND MOLDS USED IN MAKING "SWISS" CHEESE.

FIG. 6.—SHAPING AND DRAINING BRIE CHEESES.

FIG. 7.—A BRIE RIPENING CELLAR. THE WORKMAN IS SHOWN TURNING A LARGE CHEESE AND TRANSFERRING IT TO A FRESH MAT.

The making of the curd is a delicate operation and one which greatly influences the quality of the finished product. If the coagulation is too slow the cream rises to the surface, and if it is too rapid the result is a dry cheese.

The morning's milk, which was frothing in the pails a few hours ago, is now transformed into a white gelatinous mass of curd, mixed with whey. The next operation, technically called "dressage," is the shaping of the cheeses in tinned iron molds (Fig. 6). With a skimmer the workman cuts horizontal slices, thin and uniform, from the curd and deposits them unbroken in the molds. The latter are placed on rush mats which rest on wooden planks.

Twelve hours later the cheeses, now considerably diminished in thickness, are transferred from the molds to "éclisses." These are wide bands of sheet zinc, perforated to permit the escape of the remaining whey. One of these is placed around each mold and its ends are fastened together by means of a button on one end and one of a number of slits in the other. When the mold is lifted the cheese remains securely clasped by the zinc band. On this a dry mat is now laid and covered with a plank. The cheese, with its band and both planks and mats, is then inverted and the wet mat and plank, which are now on top, are removed. Ten hours later the cheese is turned again in the same manner and is salted by removing the band and sprinkling salt over the top and side. Ten or twelve hours after the first salting the cheese is turned once more and when the whey has ceased to exude the band is finally removed and the second face is salted. The cheeses are then laid on shelves, on dry straw mats, and are turned night and morning for two days, after which they go to the drying room, a large and well-ventilated cellar kept at the temperature of 53.6 deg. F., and furnished with wooden shelves on which the cheeses are laid.

Here the ripening process commences. In a short time a downy white mold, *Penicillium candidum*, appears on the surface of the cheese. This fungus destroys the lactic acid and prepares the way for other organisms which complete the ripening process in the ripening cellars to which the cheeses are transferred two weeks later (Fig. 7). Here the cheeses soften under the influence of *Bacillus firmatatis*, which has been studied by M. G. Roger. The colonies of this highly-colored bacillus appear first as yellow, later as red spots, and its secretions check the development of the white *Penicillium*, which ceases to grow while the red colonies become diffused through the entire substance of the cheese, which they convert into an elastic paste of deep cream color. Finally, a third marauder, the *Micrococcus meldensis*, discovered by M. G. Roger, comes upon the scene and stops the work of the *Bacillus firmitatis*, which, but for this intervention, would soften the creamy cheese too greatly and would ultimately cause "running," that nightmare of cheese makers. The work of these infinitesimal organisms, therefore, is divided into three stages. The first germ destroys the lactic acid; the second, more vigorous, drives out the first; and the third, in consequence of its production of diastases, plays the part of moderator and preserves the cohesion of the mass. But these industrious micro-organisms have an enemy, the *Penicillium glaucum*, or common green mold, which sometimes disturbs their mysterious operations (Fig. 8). The green or black spores of this fungus give the crust of the cheese a tint which lowers its market value. Brie which is affected with this malady, which the manufacturers call "the blues," also acquires a bitter taste. To resist the invasion of this dangerous cryptogam it is necessary to disinfect thoroughly the ripening cellar and all the utensils employed. Tubs, molds, zinc bands, and skimmers are washed with boiling soda lye; the cellars and drying rooms are whitewashed and fumigated with sulphur.

The principal wholesale market for Brie cheeses is at Meaux (Seine et Marne), where sales take place weekly, on Saturdays. Brie cheeses are of various sizes; the "grand moule" (Fig. 7), averaging 16 inches in diameter and weighing 6½ pounds; the "moyen moule," 12 inches and 4 pounds, and the "petit moule," or Coulomnier, the diameter of which varies from 5 to 10 inches according to locality.

To the same class of products belongs the cheese first made at Camembert, in the department of the Orne, which differs from Brie only in being smaller. The curd is made and shaped and the cheese salted and ripened almost exactly as described above (Fig. 9).

Finally, mention should be made of washed cheeses, which differ from the foregoing varieties by being ripened without the aid of fungous growth. The principal types are Géromé, Pont l'Evêque, and Livàrot.

In the manufacture of Géromé the milk is curdled at a temperature of from 81 to 90 deg. F., so that coagulation is completed in two hours. The curd is then cut into pieces measuring three-quarters of an inch every way and allowed to stand for half an hour, after which the whey is removed by means of a colander with small holes. The curd is then put into tinned iron molds which rest on wooden gratings supported by planks. When the curd has settled well down in the mold five or six hours after filling, the mold is inverted on a dry mat. In the evening this operation is repeated and on the following day the cheeses are transferred to forms of less height. At night they are turned again and on the third day salt is applied to the rim and one face, and, twelve hours afterward, to the other face. The Géromé cheeses are then sent to the drying room, where they remain two or three days, after which they are turned once more and taken to a cellar kept at a temperature of 54 or 55 deg. F. Here they are turned and wiped with a cloth wet with warm brine every other day. They gradually acquire a reddish tinge and at the end of two months the

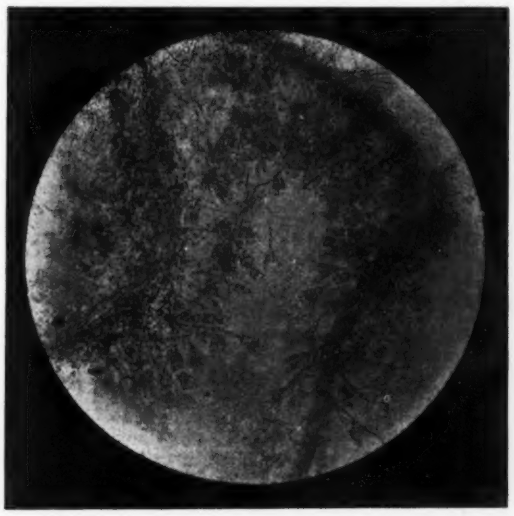


FIG. 8.—PENICILLIUM GLAUCUM, ENLARGED ONE HUNDRED AND EIGHTY TIMES. THIS FUNGUS CAUSES "BLUES" IN BRIE CHEESE.

FIG. 9.—SALTING CAMEMBERT.

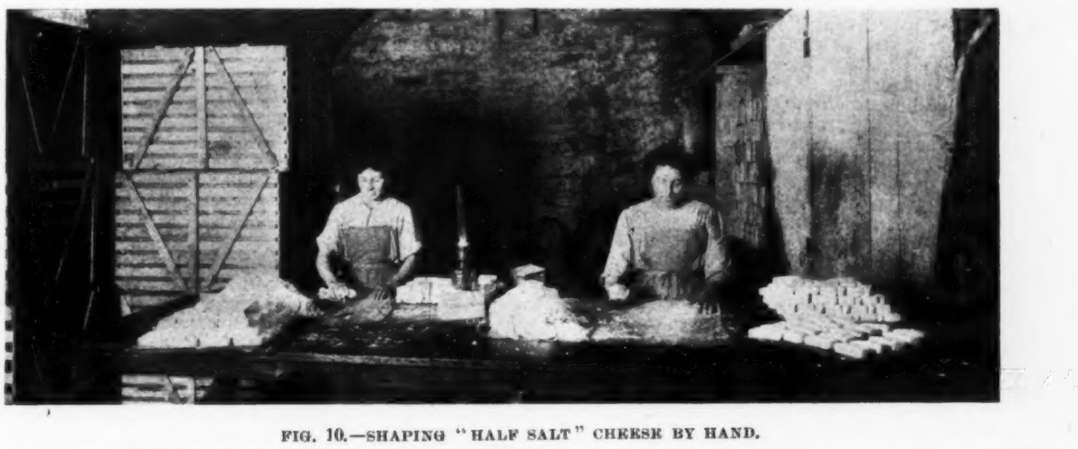


FIG. 10.—SHAPING "HALF SALT" CHEESE BY HAND.

HOW SOFT FRENCH CHEESES ARE MADE.

ripening is complete. According to M. Charles Martin's excellent work on the dairy (1904) the size of Gérômé cheeses has been reduced in recent years. Originally they weighed from 4½ to 11 pounds each.

The best Pont l'Evêque cheeses are made in the valley of Ange. Coagulation is effected in twenty minutes at from 85 to 104 deg. F. The whey which covers the curd is then removed and the curd is cut with a wooden knife and placed to drain on reed mats called "glottes." The curd is covered with cloth to keep it warm. It is then put into square molds, which are turned ten times during the first half hour, after which they are placed on fresh and thoroughly dry mats and turned five or six times more in the course of the day. At the end of forty-eight hours, the cheeses are taken from the molds, salted, and placed on gratings covered with straw in the drying room, where they remain four days, and are turned daily. Then they go to the ripening cellars, where they are placed on edge, in contact with each other, in order to prevent the development of fungous growths. They are turned every second day and become ready for market in three weeks.

Livârot cheese is made from partly-skimmed milk, coagulated in an hour and a half at from 85 to 104 deg. F. The curd is cut with a wooden knife and placed either on cloths or on reed mats, where it is allowed to drain for a quarter of an hour. During this time the curd is broken up with the fingers into particles of the size of a grain of wheat. It is then put into tinned iron molds, six inches in height and diameter, which are turned at intervals until the cheese has become solid. The cheese is then salted and is allowed to drain for five days longer. After a sojourn of a fortnight in the drying room it goes to the cellar, where it is turned three times a week and wiped, each time, with a cloth saturated with brine. Finally, it is wrapped with sedge leaves to keep it in shape. The ripening process occupies from three to five months, according to the size of the cheese. Before being shipped, Livârot cheeses are colored superficially.

[Continued from Supplement No. 1641, page 26295.]

ARTIFICIAL FERTILIZERS: THEIR NATURE AND FUNCTION.—III.*

By A. D. Hall, M.A., Director of the Rothamsted Experimental Station, Lawes Agricultural Trust.

THE NITROGENOUS MANURES.

We can begin by dividing the nitrogenous manures into two classes, the quick and the slow acting, in the first of which we have practically only nitrate of soda, sulphate of ammonia, cyanamide, and nitrate of lime. Our acquaintance with the latter two is too limited as yet to enable us to do more than predict that they will fall into line with sulphate of ammonia and nitrate of soda respectively. Nitrate of soda has now been in use in this country for something like seventy years, the Chilian deposits having been first discovered about the time of Darwin's voyage around the world in the "Beagle." As niter had long been known to possess great manurial value, the exportation of nitrate of soda to Europe was at once suggested, and in 1830 it appears that a trial shipment was made of 18,700 quintals of about 100 pounds each. By 1838, the date of the first volume of the Journal of the Royal Agricultural Society, it was being tried experimentally by a good many landlords and farmers in this country. The production grew rapidly, and reached its maximum in 1899 when 1,344,550 tons were consumed; since then the output has declined a little owing to combination between the producers. At the present time the United Kingdom takes about one-twelfth of the total production, Belgium an equal share, France and the United States about one-sixth each, and Germany rather more than one-third of the whole. Opinions differ greatly as to the approaching exhaustion of the Chilian deposits; various estimates set their probable life at from twenty to forty years, but doubtless long before exhaustion sets in, the poorer grounds, now being neglected as containing less than the paying amount of nitrate, will be exploited, provided always that the artificial nitrate of lime does not render the whole industry unprofitable.

As to the origin of the nitrate of soda deposits there are two theories, to understand which some description of their mode of occurrence is necessary. The chief deposit lies in the province of Tarapaca, in Chile, on an elevated plain known as the Pampa of Tamarugal, about 3,000 feet above sea level, stretching for a breadth of some thirty or forty miles from the Cordilleras on the eastward to a low range of foothills separating it from the sea. The climate is intensely dry, rain falling only every two or three years, and then only in quantities which rapidly evaporate. The special nitrate-bearing deposit or *caliche* occurs a few feet below the surface, and is associated with earthy matters, gypsum, common salt, and sulphates of sodium and potassium. The generally accepted theory regards the plain as an ancient sea bed elevated by one of the volcanic movements common on that coast, and then desiccated. The nitrate of soda is set down to the oxidation of immense masses of seaweed present in the original sea, the salt of which has provided the necessary sodium base. The chief argument in support is the presence of a small amount of sodium iodate in the crude caliche, seaweed being known to contain iodine. But such a theory is as impossible on chemical grounds as it is untenable geologically. It involves in the first place an extravagant amount of seaweed, and our knowledge of the nitrification process is quite opposed to the idea that it would take place in a rapidly concentrating medium containing common salt. Nor have we any reason to suppose that salt would supply a base for nitrification, even if its hydrochloric acid could be turned out, the liberated acid would at once suspend the process. And again if the iodates are to be taken as indicating seaweed, why are not bromates also present in the caliche, since both bromine and iodine are associated in seaweed?

A much more probable theory is that the deposit represents the desiccated residues of fresh water streams flowing off the Cordilleras, containing nitrates and other salts derived from old rich soils or rocks on the heights. The evaporation of such waters for a long period of progressive desiccation would result in the accumulation of the dissolved salts in the dry region over which the waters formerly spread when the rainfall was greater. The occurrence of iodine cannot be explained until more is known as to the amount of this element present in the water and soils of the Cordilleras.

The only other deposits of nitrate of soda which assume any economic importance are those which occur in Upper Egypt, where certain shale beds of Eocene age, outcropping on both sides of the Nile between Qené and Assouan, contain enough sodium nitrate to make the clay worth carriage as a manure, known locally as "tafla." Analyses of a series of these shales by Mr. F. Hughes shows an average of 6.7 per cent of nitrate of soda associated with 10.1 per cent of sodium chloride, and 5.4 per cent of sodium sulphate. The material is disseminated throughout the whole bulk of the clay, and as this is not permeable to any extent by water the nitrate can hardly be due to infiltration, but must have been formed *in situ*; a conclusion which is much strengthened by the fact brought out by Mr. Hughes's analysis that small quantities of nitrogenous organic matter, ammonia, and nitrites, are also present in the extract from the clay.

In all probability the nitrates in these shales represent the results of nitrification of a mass of organic matter originally contained in the deposit, but until further data have been accumulated as to the depth to which the nitrates extend, and their replacement or not by unoxidized organic nitrogen compounds at depths beyond the access of atmospheric oxygen, it is impossible to say whether we are dealing with recent or what might be termed fossil nitrification, or again whether there has been any concentration of the salts in the surface layer analyzed.

In any case these Egyptian deposits give a clue to the possible origin of the Chile beds by the washing out of similar strata (and the Cordilleras consist of rocks of recent age) into a rainless area where the salts are accumulated by evaporation.

The two deposits present this common difficulty, that the deposit is nitrate of soda instead of nitrate of lime, the usual result of nitrification in soil; again, both are associated with a preponderance of sulphates over chlorides, a fact which seems to put any marine origin out of the question. We are, however, dealing with typically arid conditions, and in all parts of the world sodium salts are characteristically abundant in the soils and rocks of areas of small rainfall; indeed, sodium carbonate is always found in such cases, and this would form the base for nitrification. At the same time, similar oxidizing processes to those which give rise to nitrates would convert the sulphur of the organic matter to sulphates. But really to settle the problem of the origin of the Chile deposits of nitrate of soda, an examination is required of the salts in the rocks of the Cordilleras, the drainage from which would find its way into the plain of Tamarugal.

As a manure, nitrate of soda is of course treated as a source of nitrogen. It is not sufficiently realized how valuable the soda base may be. This is not because soda is in any way necessary to the nutrition of the plant, but because of the action of any soluble salt upon the insoluble potash compounds in the soil. The potash of the soil is due to the partial weathering of double silicates like felspar, into clay, which is not to be regarded as pure kaolinite, $Al_2O_3\ 2SiO_2\ 2H_2O$, but as containing a certain proportion of zeolitic bodies intermediate between felspar and kaolinite—hydrated double silicates containing potash, soda, magnesia, and lime combined with alumina and silica. Any soluble salt, and particularly a soluble soda salt, will react with these zeolites and exchange bases to an extent depending upon the relative masses of the two bodies, hence nitrate of soda acts on the clay in the soil and brings a little potash into solution. To such an extent does this action take place, that in practice a dressing of nitrate of soda on any but the lightest soils will dispense with the necessity of any specific potash manuring even for potash-loving crops.

This is well illustrated in the Rothamsted experiments (see Table XI.) upon mangels, if we compare

TABLE XI.

Plot.		With Nitrate of Soda.	With Sulphate of Ammonia.	With Rape-cake.
		Tons.	Tons.	Tons.
6	Superphosphate and potash	29·6	28·2	29·4
5	Superphosphate only	28·3	12·0	14·9

the yields on the plots receiving equivalent amounts of nitrogen as nitrate of soda, sulphate of ammonia, and rape cake, both with and without potash. The table refers to the season of 1900, the twenty-fifth year of that series of experiments, when it might be supposed the potash in the soils of the plots receiving no potash in the manure must have become thoroughly exhausted.

The plots receiving potash all give about the same yield whatever the source of nitrogen, but on plot 5 without potash the yield is only maintained on the nitrate of soda plot; on the other two the plant is neither supplied with potash by the manure, nor is the soil forced to give up its reserves as it is by the nitrate of soda alone, and the yield declines by one-half or more. In twenty-five years, then, the use of nitrate of soda alone has enabled the soil to supply a mangel crop with the large amount of potash it wanted, though the store of potash in the soil apparently soon becomes exhausted when a manure is used which cannot bring it into solution. With other crops the same results are manifest, though not so quickly as in the case of mangels. For example, we may compare the yield of barley (Table XII.) for successive ten year periods, and to eliminate seasonal influences the yield of each plot will be calculated as a percentage of that on the completely manured plot receiving nitrate of soda.

TABLE XII.

Barley Grain, Hoosfield, Rothamsted.

Plot.		10 years, 1852–1861.	10 years, 1862–1871.	10 years, 1872–1881.	10 years, 1882–1891.	10 years, 1892–1901.
4 N	Nitrate, superphosphate and potash	100	100	100	100	100
2 N	Nitrate and superphosphate	98·0	100·2	99·5	105·7	101·4
4 A	Ammonia, superphosphate and potash	92·4	93·7	97·2	100·7	100·8
2 A	Ammonia and superphosphate	91·4	97·8	96·0	90·8	77·8

It will be seen that when the manure contains potash the ammonia salts yield practically the same crops as nitrate of soda. When the nitrogenous manure is nitrate of soda the omission of potash causes no diminution in the yield; but with ammonia salts and no potash the crop after the third decade becomes unable to satisfy its potash requirements from the soil alone and the yield declines. In other words nitrate of soda has dispensed with the necessity of a potash dressing, which is wanted when sulphate of ammonia is the nitrogenous manure.

One of the most characteristic effects of the use of nitrate of soda as a manure, either repeatedly or in any quantity, is its deleterious effect upon the texture of a heavy soil; farmers have repeatedly observed that the land remains very wet and poaches badly if it is at all disturbed before it has dried. Market gardeners in particular, who manure heavily with nitrate of soda, have found this destruction of the tilth a serious drawback to its use. The cause has usually been put down to the hygroscopic character of nitrate of soda; since the salt itself readily attracts moisture from the air and will even liquefy spontaneously, it is considered that it keeps the land moist for the same reason. But the extra amount of moisture that could be held in the soil by a few hundred-weight of nitrate of soda would be wholly imperceptible when distributed through the hundred tons or more which the top inch of soil weighs per acre, even if the application of nitrate of soda persisted near the surface and were not quickly washed down in the soil. Some of the Rothamsted plots in the Barnfield growing mangels, where very large amounts of nitrate of soda have been applied year after year for the last fifty years, show this deterioration of tilth in very marked fashion, the land being intolerably sticky after rain and drying into hard intractable clods, so much so that it is very difficult to secure a plant of roots unless the season is favorable. Determinations, however, of moisture in the surface soil do not show any sensible difference between these plots and those working more kindly, so that we must put aside the idea that there is any direct attraction of water by nitrate of soda remaining in the soil. The explanation appears to be more complex. When a plant is feeding upon a neutral salt like nitrate of soda it takes up rather more of the nitric acid than of the soda, leaving some of the soda in the soil combined with carbonic acid excreted from the root. Water cultures in which plants are grown with nitrate of soda will actually become alkaline to test paper from this cause. Now a very small quantity of a free alkali like carbonate of soda has an altogether disproportionate effect upon clay; the clay is deflocculated, i. e., the little aggregates of very fine particles which cause the clay to crumble down when dry and to allow water to drain through it, are immediately resolved into their finest state of division, and all the characteristic properties of clay are accentuated. Deflocculation is effected mechanically whenever clay is puddled or worked in a wet condition, and all the features of puddled clay, which is both retentive of water and impermeable by it, which shrinks greatly in drying and then holds together with extreme tenacity, are found in these soils when the deflocculation is brought about by a little dissolved alkali. The fact that such deflocculation has taken place may be illustrated by a very simple experiment. Here are two large jars, each containing three liters of distilled water, in which has

* From the Journal of the Society of Arts.

been shaken up one gramme of the Rothamsted clay loam, in the one case from a plot manured with nitrate of soda, in the other, from the adjoining plot receiving ammonia salts. It is already obvious how much longer the nitrate of soda jar is going to be before the sediment has all deposited, which means that the soil under these influences is kept in a more fine-grained and less flocculated condition. Collateral evidence is furnished by some of the other Rothamsted plots; for example, when the tile drains beneath the wheat plots run, the water percolating from below the nitrate of soda plot is always slightly turbid with fine suspended clay material, while the water from the other plots is clear. This removal of the finest material from the nitrated plot has been so persistent during the fifty years or so of experiment on this field, that it is now even perceptible in the analysis; it has only been possible because of the deflocculation brought about by the nitrate of soda manuring.

Again, the soil of these plots receiving nitrate of soda is found to be losing carbonate of lime to the water percolating through it at a lower rate than the soil of the unmanured plot; this is because the production of a free base by the plant's own growth has, to a certain extent, saved the carbonate of lime in the soil from attack. The following table (XIII.) shows the annual average rate of loss of carbonate of lime for the last forty years from some of the chief plots

TABLE XIII.—CALCIUM CARBONATE IN BROADBALK WHEAT SOILS.

1st Depth (1-9 inches).

Plot.		Per cent. in fine dry soil. 1865.	Per cent. in fine dry soil. 1904.	Loss per acre per annum.
		Per cent.	Per cent.	lb.
3	Unmanured	4·54	3·29	800
9	Complete minerals and 275 lb. nitrate of soda	4·24	3·36	564
7	Complete minerals and 400 lb. ammon. salts	3·82	2·25	1010

of the Broadbalk field; it will be seen that the nitrate of soda has reduced the loss of carbonate of lime from the soil. The bad texture of the land induced by the use of nitrate of soda is not easily removed; lime is of no service in this case, because it only adds another alkali; a better remedy is to be found in the simultaneous application of an acid manure like superphosphate. Or a mixture of sulphate of ammonia with nitrate of soda might be employed; for, as will be seen later, sulphate of ammonia acts on soil like an acid, hence a mixture of the two manures ought to make a better source of nitrogen than either alone.

The great rival of nitrate of soda it at present sulphate of ammonia, of which over 200,000 tons are annually produced in this country. The source of origin is coal, which contains about 1.5 to 2 per cent of nitrogen derived from the original vegetable matter giving rise to the coal. When coal is subjected to any destructive distillation by heat, as in the process of gas-making or even when it is burnt, about fifteen per cent of its nitrogen is given off as ammonia, which may be recovered from the gases by simply washing them with water. The ammoniacal gas liquor thus produced is redistilled into sulphuric acid and the sulphate of ammonia crystallized out; the commercial salt resulting contains about 20.5 per cent of nitrogen. Not only gas works, but blast furnaces, coke ovens, shale oil works, etc., are now arranged to recover this valuable product of the coal, and the accompanying Table (XIV.) shows the current output from each of these sources.

TABLE XIV.—PRODUCTION OF SULPHATE OF AMMONIA IN THE UNITED KINGDOM.

Source.	1901.	1900.	1899.
	Tons.	Tons.	Tons.
Gas works	148,500	142,000	134,000
Iron works	16,000	17,000	18,000
Shale works	36,500	37,000	38,500
Coke, &c., works	19,000	17,000	15,000
Total production	220,000	213,000	205,500
Exports	150,203	145,285	140,371
Home consumption	69,797	67,715	65,129
Average price ..	£10 11 4	£11 2 0	£11 5 10

As a nitrogenous manure, sulphate of ammonia is practically as effective, nitrogen for nitrogen, as nitrate of soda; it is also to all intents and purposes as rapid in its action, for the process of nitrification, which generally precedes the utilization of the ammonia by the plant, takes place very rapidly in suitable soils. The fact is well illustrated in the following table (XV.) showing the composition of the water draining from one of the Rothamsted wheat plots to which a mixture of sulphate and chloride of ammonia had been applied on October 25, followed the next day by heavy rain, so that on the 27th the drains began to run. It will be seen that at this early date the ammonia had not been wholly caught up by the soil, so that a little found its way into the drains; at the same time, however, the proportion of nitrate has been enormously increased, due to immediate nitrification, and the later runnings of the drains in November and December show that the ammonia salts were being rapidly oxidized and removed from the soil as nitrates.

But though the yield produced by nitric and ammoniacal nitrogen is much the same, with a little advantage on the side of the nitrate, there are certain

TABLE XV.—BROADBALK WHEAT FIELD, ROTHAMSTED.

Nitrogen and Chlorine in Drainage Water from Plot 15. Parts per million.

	Nitrogen as Ammonia.	Nitrogen as Nitrates.	Chlorine.	Nitrogen as Nitrates to 100 Chlorine.
1880. Oct. 10	None	8·2	22·7	37·0
1880. Oct. 27, 6.30 a.m.	9·0	13·5	146·4	9·2
1880. Oct. 27, 1 p.m...	6·5	12·9	116·6	11·1
1880. Oct. 28	2·5	16·7	95·3	17·5
1880. Oct. 29	1·5	16·9	80·8	20·9
1880. Nov. 15, 16	None	50·8	54·2	93·7
1880. Nov. 19, 26	None	34·6	47·[illegible]	72·7
1880. Dec. 22, 29, 30..	None	21·7	23·2	93·5
1881. Feb. 2, 8, 10....	None	22·9	19·4	118·0

specific differences in the action of the two manures which are worthy of examination. It has been already explained that the soda base in the one case is of some service in liberating the stock of potash in the soil; the fact that in sulphate of ammonia the nitrogen is combined with an acid and contains no fixed base causes the manure to be positively harmful on certain soils. When sulphate of ammonia is applied to the soil the first action is an interchange between the ammonia and some of the bases in the soil, the ammonia takes the place of an equivalent amount of lime and magnesia in the zeolitic double hydrated silicates in the clay, but finally the reaction mainly falls upon the calcium carbonate in the soil, ammonium carbonate being formed as a preliminary to nitrification and calcium going into solution as calcium sulphate. Referring again to the analyses of the Rothamsted wheat soils, it will be seen that the long continued use of ammonia salts has reduced the proportion of calcium carbonate below that of the unmanured plots by amounts which are approximately those to be expected if a reaction of the nature—

$(NH_4)_2SO_4 + CaCO_3 = (NH_4)_2CO_3 + CaSO_4$ alone took place.

The Rothamsted wheat soils started with sufficient calcium carbonate to withstand this loss, but on soils initially poor in calcium carbonate its removal by sulphate of ammonia soon induces a condition approaching actual sterility. The best example is afforded by the experimental plots on the farm of the Royal Agricultural Society at Woburn, where the soil is sandy and only contained at the outset 0.087 per cent of calcium carbonate. There, through the continued use of ammonia salts as manure, the soil refuses to grow barley any longer, though the former fertility is at once restored by the application of a dressing of lime. At Woburn, the soil of these plots receiving ammonia salts is actually acid to litmus paper, and a similar condition prevails on some of the grass plots at Rothamsted, where the soil, unlike that of the wheat field, is deficient in calcium carbonate. The origin of this acid reaction is not exactly easy to understand, for there is never any production of acid by the mere reaction of sulphate or chloride of ammonia with any of the constituents of soil—clay, humus, or silica. As far as the investigation has yet proceeded the acid reaction is due to the attack of soil organisms, chiefly fungi, upon the ammonium salts, the ammonia being withdrawn to leave the acid free.

(To be continued.)

RENNET.

THE young calf has the advantage over the young human baby, not merely that he has four stomachs, but that in one of these there is secreted a substance which assists the digestion of the mother's milk. This substance, secreted from special pores, is called rennet, and is used in domestic arts for two purposes: (1) To thicken or "lopper" milk in one of the two principal methods of cheese making and (2) in making a most delightful and readily-digested dessert of low cost and ready preparation.

It should be mentioned at first that there are two principal methods of bringing the milk to the cheese-forming or casein-separating condition. The first of these is by the addition of rennet to sweet milk; the second by the employment of acids, especially of lactic acid—that contained in the milk itself. The first process is the most convenient and most important, and a consideration of the material employed in effecting the separation of the casein may not be uninteresting.

The rennet secreted in the stomach of the calf is what is known as an amorphous or unformed ferment; very little of it tends to set up the "loppering" of the stomach contents. If the latter have not been, by some special change of temperature or an addition of some special chemical, prevented from undergoing the desired change. Rennet is much like the albuminous series, of which the white of egg is the best known to the average person. Boiling, or the addition of an alkali, deprives it of its usefulness in cheese making. The promptness and extent of its action on the milk depends on the temperature and quality of the latter, and the quantity of rennet added, as well as on the condition of this material itself.

If the milk is warm it will set more quickly and firmly, and produce a cheese which contains less water than that from unwarmed milk. In the other direction, cooling it below a certain limit delays the process of "loppering," and the fracture of the cheese is more soft and irregular. A. Meyer sets the limits of greatest efficiency of the rennet as between 37 deg. and 38 deg. C. (98.6 deg. and 100.4 deg. F.); that is, from normal blood temperature up to a point a trifle beyond this.

Naturally, it is not to be expected that a milk which contains large quantities of water will yield a good cheese, or that the rennet will have a rapid effect thereon; there is no casein in water. It makes, also, a difference whether the casein contains much or little phosphate of lime or of magnesia; as alkalies destroy the effect of the rennet as well as boiling does.

Milk that is slightly soured, and hence is not at all alkaline, submits more readily to the action of the rennet than that which is not so soured; and it will thicken more quickly than sweet milk.

Milk that has been boiled resists entirely the action of the rennet; and the so-called "colostrum" milk, or that which the cow yields during the first short period after calving, will not only not thicken, but will also, if added to normal milk, prevent this from yielding cheese.

It may be said in general that if a given quantity of rennet will thicken a certain amount of milk in a stated time, double the quantity will (other things being equal) effect the desired change in half the time—naturally within certain limits; and the presence of an excess of rennet will add an unpleasant taste to the product. If we allow three-quarters of an hour for the thickening of the milk with two per cent of rennet, we will have the same effect with one per cent in one hour and a half, or in 22½ minutes with four per cent; for the rennet does not act like a chemical which neutralizes another substance, or combines with it to form another substance, but is a ferment setting up a process extending itself from mass to mass until all is disintegrated.

It is certain that if any phosphorus salts are present, no amount of rennet will separate the casein. Engling states that the lime phosphate is dissolved; but Soxhlet, so well known in connection with sterilizing milk, says that the rennet itself acts like a dilute acid; so that the effect produced thereby is like that caused by the addition of lactic acid. No dehydration takes place when alcohol is added thereto.

In order to judge of the strength of the rennet, so as to add the proper quantity, it may be tested by noting its action on a given quantity of milk at a given temperature—say one liter of milk at 35 deg. C. (95 deg. F.); the time required to effect complete thickening is then noted. The term "complete thickening" is employed in connection with the time when the mass separates completely from the wall of the containing vessel when this latter is tipped.

Soxhlet suggests that the normal time of thickening be taken at 40 minutes when the temperature is 35 deg. C. (95 deg. F.); and when rennet is spoken of as having a strength of 1 : 100, it means that one cubic centimeter thereof will thicken a liter of milk in 40 minutes at a temperature of 40 deg. C. (104 deg. F.). If, for example, the time to thicken is four minutes, the strength of the rennet will be:

4 : 1,000 : : 40 : x or

1,000 × 40 4 = 10,000, and so on.

Another example: It is required to thicken 400 liters of milk of a temperature of 35 deg. C. (95 deg. F.) in 40 minutes, with rennet having a strength of 1 : 10,000; then 10,000 : 400 : : 1,000 : 40, the number of cubic centimeters of rennet necessary.

If the temperature is not the normal, 35 deg. C., the strength of the rennet, or the quantity necessary, must be determined otherwise. Thus with a strength of 9,000 and 400 liters of milk at 30 deg. C. (86 deg. F.):

9,000 : 400 : : 1,000 : 62.5, the number of cubic centimeters necessary.

If the milk is to be thickened in less than 40 minutes, the amount of rennet should be inversely proportionate to the time required; thus for 30 minutes there should be one-third more rennet used, that is, 62.5 × 4 ÷ 3 = 83.3 cubic centimeters.

The rennet should be clear, and have no smell at all and but little taste; if it has any taste at all, it should be slightly salty. It does not improve by age—on the contrary; and it should be kept in a cold dark place. To prevent its changing in keeping, it is well to add a trifle boracic acid or of alcohol; but if the latter is employed, the vessels must be kept closed to prevent the formation of acetic acid from the alcohol, as this would ruin the rennet.

To make essence of rennet, Soxhlet recommends taking 100 grammes of finely chopped rennet stomach of a calf three weeks old, and macerating it for several days in a liter of a five per cent solution of cooking salt in which 40 grammes of boracic acid have been dissolved. There are then to be added 50 grammes of common salt, and the solution is to be filtered through paper or cloth. The filtered solution will then have a strength of about 1 : 18,000; 800 cubic centimeters thereof added to 200 cubic centimeters of a 10 per cent solution of cooking salt saturated with boracic acid, will give one liter of so-called "essence," that after two months standing in a cold dark place will still have a strength of about 1 : 10,000.

There is also found in commerce, rennet powder,

which is very strong; some brands will, at a temperature of 40 deg. C. (104 deg. F.) thicken from 250,000 to 300,000 times their weight. The powder does not lose its strength by keeping, as the liquid essence is liable to do. It is to be dissolved in water (as little as possible) and used the same as the so-called essence.

Rennet tablets are used in both Denmark and America; they are to be dissolved in water the same as the powder, and have the same effect.

[Concluded from Supplement No. 1641, page 26298.]

HOW TO BUILD A 5-HORSE-POWER STATIONARY GAS ENGINE.*

By E. F. Lake.

Finishing the Piston and Rings.—The piston, Fig. 2, can easily be turned in the lathe by centering the boss on the head and the bar which is cast across the open end. The slots for the rings should be turned to the exact width, so that the rings can all be made of one size and interchangeable. A small hole should be drilled in the bottom of each slot where the thick part of the ring will come, when assembled, and a tight pin inserted, which pin will fit a corresponding hole in the ring to prevent it from turning on the piston. The pin should project about ⅛ of an inch from the bottom of the slot and the hole in the piston ring should not be over ⅛ of an inch deep.

be chucked in the lathe, turned out on the inside to 5¾ inches diameter, then set 1/16 of an inch off the center and turned on the outside to 6⅛ inches in diameter. This will make the rings eccentric, as they will be ⅛ of an inch thick on one side and ¼ of an inch on the other. They should be left a few thousandths larger in turning and then ground to the exact size in order to give them a smooth surface on the outside diameter where they bear against the bore of the cylinder. After this the rings can be cut off. They should fit exactly in the slots in the piston, yet loosely enough not to stick, as they must at all times have their natural spring to hold them tightly against the cylinder wall. This spring should be about 15 pounds to the square inch. After turning, grinding, and cutting them off, the rings are split by cutting out 13/32 of an inch on each side, half way through, as shown in Fig. 3A.

The piston pin, as shown in Fig. 29 should be made short enough so that it will not touch the cylinder wall. By drilling out the center and piercing a small oil hole in the center of its length, the connecting rod will be sufficiently lubricated. As there is not much motion at this point a little oil is all that is necessary, and this will run in from the cylinder wall.

The Connecting-Rod.—The connecting-rod, as shown in Fig. 4, is almost invariably made of forged steel of a good grade. Most gas engine makers prefer a 2 or 2½

signed so that the lift of the valve is greater for the exhaust, thus giving both valves the same diameter.

The valves should be made of a special valve steel. One containing about 30 per cent of nickel and 5 per cent carbon is the best for this purpose, as the nickel keeps it from overheating and the carbon makes it hard enough to wear well.

The next best metal is cast iron, the stem being of steel, threaded and screwed into the valve. This latter style is used in many engines and is quite satisfactory. The valves should be turned on their entire surface and threaded on the end of the stem to receive a special nut, Fig. 12, to hold the valve springs in position. This nut has a projection fitting inside of the spring. After threading, a slot should be cut in the top so that, with the aid of a screw driver bit and brace, the valve can be ground into its seat in the cylinder by the use of powdered glass and oil.

The valve springs, Fig. 13, should have enough tension to insure their riding on the cam; otherwise they will rattle. Still they must not have too much tension; otherwise an undue wearing of the parts will result.

The valve caps, Fig. 9, of which two are required, are next turned up so as to fit snugly in the cylinder.

They should be screwed to the cylinder, as shown, with a copper gasket between them and the top of the cylinder to prevent leakage. The valve cap over

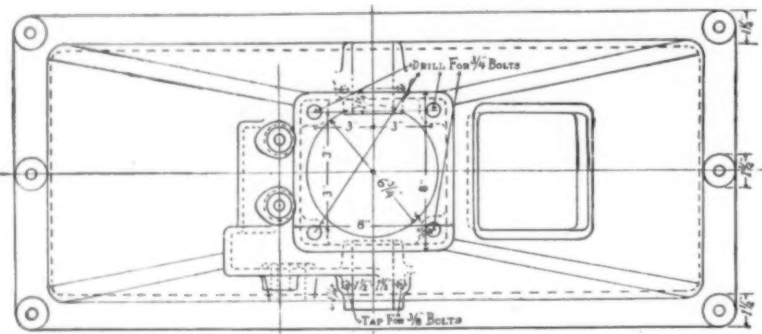


Fig. 20B

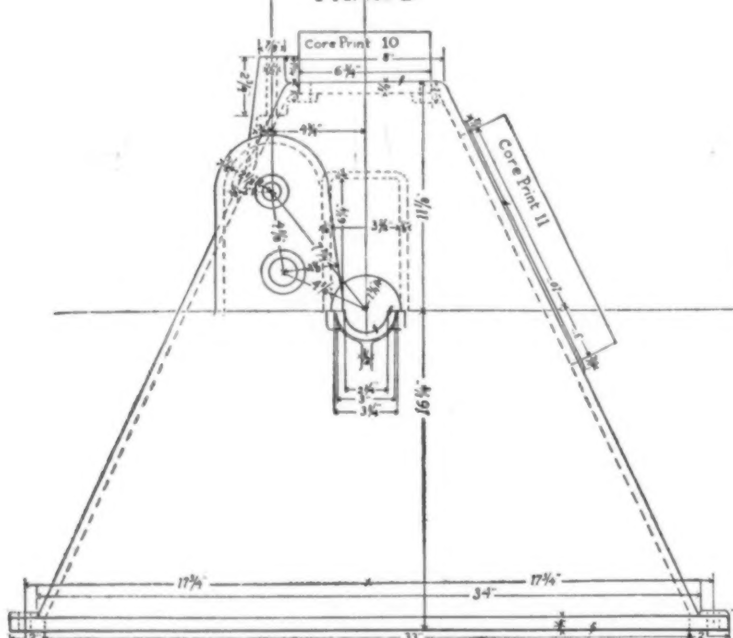


Fig. 20

Engine Base

Cast Iron

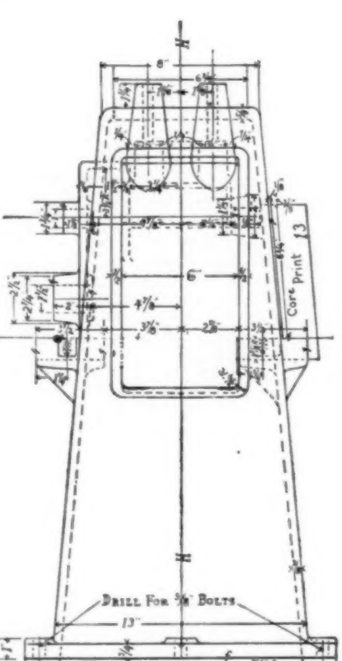


Fig. 20A

Care must be taken in drilling these holes in the piston, so they will not cut through to the center of the piston, as this might cause a leakage of the gases.

After the piston is turned down to six inches in diameter it should be ground to as smooth a surface as possible and tapered, the bottom of the piston being made in diameter 0.003 less than 6 inches, or the bore of the cylinder, and the top of the piston; or, the ring end should be 0.008 of an inch smaller in diameter, so as to allow for the expansion of the piston caused by the heat of the explosions. After this is done it can be chucked and the boss used for centering turned off. It is not essential that the head of the piston be turned. Only the rough spots should be filed off; for they may be heated and cause preignition of the gases. The hole for the piston pin can then be drilled and counterbored between the bosses, and the piston pin fitted in, after which the piston can be turned on end and the hole for the set screw drilled through the boss and piston pin. Next the pin can be taken out, and the hole in the boss tapped to fit the set screw. The set screw, Fig. 29, should have a hole drilled through the head so that when it is assembled a cotter pin can be put in to prevent it from working loose and allowing the piston pin to float, thus scoring if not destroying the cylinders.

The tube for making the piston rings, Fig. 3, should

per cent nickel steel, although some use a much better grade than this, such as chrome, chrome-nickel or vanadium steel. Others have used cast manganese bronze successfully in which case, however, the connecting-rod must be made of larger section than that shown in the drawing. Moreover, instead of being round between the bearings, it should be I-shaped in section.

Our connecting-rod can be finished by facing off its shank and the cap where they meet, drilling and tapping the bolt holes, bolting the parts together with a liner between so that the wear can be taken up, drilling the hole for the bronze bearings, Fig. 6, and finally counterboring both sides, so that the rod will fit the crank shaft. Next the hole for the piston pin is drilled in the other end, and both sides are counterbored so that the rod will fit between the bosses in the piston. No bearing metal is needed at this point, because the rod's motion is only about ¼ of an inch back and forth on the piston pin. Some makers for the sake of neatness turn the rod, round, between the two bearings, but this is not a necessity. The holes for the bearings must be drilled square with the length of rod, and in line with each other, or the crank shaft and piston pin will not line up as they should.

Valves.—The inlet and exhaust valves, Fig. 11, have been made the same size, so they can be interchanged. Some engine builders make the exhaust valve larger in diameter than the inlet, but these have been de-

the inlet valve should be drilled and tapped to hold the spark plug; for at this point the spark plug will be kept free of the carbon (which is liable to be deposited) by the current of cool incoming gas which rushes past. The cap over the exhaust can have a pet cock in it to vent the cylinder when desired.

With these operations completed, the cylinder and its parts are ready to be assembled.

The Crank Shaft.—The crank shaft, Figs. 7, 7A, and 7B, should be forged in a slab, of a semi-hard carbon steel or a 4 to 5 per cent nickel steel. After forging it should be thoroughly annealed to remove any internal strains caused by forging. It should then be blocked out to the shape shown in Fig. 7A by drilling holes along the edge and breaking off the metal not needed, leaving enough metal for machining. Next it should be rough cut to reduce it nearly to the proper size. It is now re-annealed by heating it to about 1,350 degrees Fahrenheit, or a white heat, and cooling it slowly by banking it in ashes or powdered charcoal over night. After this the shaft can be finished by turning it down nearly to size and grinding it for the bearings to give it a smooth surface. After grinding, the key ways for the flywheels and the belt pulley should be cut. Oil holes should be drilled from the main bearings to the connecting-rod bearings, of ⅛ or 3/16 of an inch diameter, and the holes for the screws that hold the counterbalance should be drilled and tapped.

* Specially prepared for the Scientific American Supplement.

The counterbalance for the crank shaft, Fig. 8, may be forged integrally with the shaft, but this would entail much more labor in forging and machining. It is therefore better to work the parts separately, as shown in the drawing. The counterbalance will look better if it is finished all over, but this is not necessary provided it has the proper weight to perform its part effectively. Still, finishing is necessary where the counterbalance fits the shaft so that it will have a tight fit to prevent its working loose. After the counterbalance is screwed on, the heads of the screws should be peened into the metal to prevent their turning and working loose.

Bushings.—The main crank shaft bushings, Fig. 27, and the connecting-rod bushing, Fig. 6, should be finished all over. After they are turned on the inside, outside and on the ends, they should be cut 1/32 of an inch back from the center line on which they are split, so as to allow for taking up of the wear. Oil grooves should be cut, diagonally, around their inner circumference about ⅛ of an inch wide and 3/32 of an inch deep, to allow the free flowing of the oil on the bearing. These grooves can be cut with a round-nosed cold chisel. There should be two grooves in each half of the bearing starting about ¼ of an inch from each end and crossing in the center. They should fit tight in the base, the connecting rod and the caps and be held with a small pin to prevent their turning and getting out of line with the oil holes. If these bearings be babbitted, which is a very common practice, much time must be spent in working the pattern, as well as on the core. Bronze bearings wear better and are more serviceable than babbitt. Unless a large number of engines are to be built from the one pattern, the bronze bearing is the cheapest.

The Base.—The base should first be finished off on the top, at core print 10, and on the bottom. Then the main bearing caps, Fig. 26, should be fitted with a liner between them and the half bearing in the base, so that the wear can be taken up. Next the holes to receive the bushings are drilled. The bushings are counterbored on the inside, so that the crank shaft and cam shaft gear, Fig. 18, will fit between them, and then counterbored on the outside so that the flywheels will bear well against them. Care must be taken to make the holes parallel with the top of the base, so that the crank shaft will line up with the cylinder. Next the holes for the cam shaft and the auxiliary gear shaft can be drilled, keeping these also parallel with the top of the base and in line with the crank shaft bearings. Then the holes for the valve push rods are drilled; these must be square with the top of the base and the cam shaft. Next the cylinder is mounted and the bolt holes drilled for bolting it to the base. The hand hole and crank shaft hole plate bearings are next faced off, although if the rough spots are removed with a file the essential requirements are fulfilled. The holes for screwing these plates on are drilled and tapped. Finally the foundation bolt holes can be drilled and the base is finished.

Cam Shaft Gears.—The power is transmitted from the crank shaft to the cam shaft by the aid of four gears. Two or even three gears would require too large a projection in the base. The cam shaft must run at just one-half the speed of the crank shaft. Fig. 18 shows the gear which is fastened to the crank shaft, while Fig. 19 shows the gear which meshes with the crank shaft gear and runs on an auxiliary shaft. The number of teeth in these two gears is immaterial as long as the auxiliary shaft gear shown in Fig. 19 has twice as many teeth as the crank shaft gear shown in Fig. 18. The pitch diameter, however, should be that indicated in the drawings, in order that the bearings in the base may have the dimensions figured. Fig. 22 shows two gears of the same pitch diameter, with the center drilled out to fit different shafts. One of these gears is mounted on the auxiliary shaft adjacent to the gear shown in Fig. 19. When assembled in the base, the cam shaft gear shown in Fig. 22 should lie nearer the outside of the base. This will then run in mesh with the cam shaft gear, Fig. 22. The number of teeth on these is not essential as long as both have the same number and the pitch diameter is 4 inches. Before drilling the hole for the auxiliary shaft in the base, it would be well to lay the gears in mesh on a board or piece of paper with 7¾ inches between the center of the crank shaft gear, Fig. 18, and the cam shaft gear, Fig. 22. The center for the auxiliary shaft hole can then be located exactly and drilled in the base. If gear-cutting tools are not handy, the gears can be bought from the standard stock of a number of different gear makers.

Cams and Shafts.—The cam shaft, Fig. 25, and the auxiliary shaft can be made of ordinary cold rolled shafting. The auxiliary shaft is held in position on the inside of the base by the gears which are fastened to it and press against the inside of the bearing. It should extend outside of the base far enough to hold a collar, thus securing and holding it in position. The cam shaft should be flush with the outside of the bearing in the base, the shaft being held in position at one end by the gear which presses against the end of the bearing on the inside of the base and at the other end by the shaft itself, striking as it does the bottom of the hole. It would be better if a collar were added at this bearing. The gears should be keyed to these shafts to prevent their slipping. The holes for the shaft bearings should be reamed out after drilling.

The cams are a very important part of the engine; for they not only control the amount of the fuel supply, but also the time at which the mixture is exhausted from or injected into the cylinder. The inlet cam, Fig. 16, is designed to lift the valve 7/16 of an inch and hold it open during 174 degrees of the revolution of the crank shaft. It should open the valve 9 degrees past the upper dead center and close it at 3 degrees past the lower dead center, to allow the incoming gases to fill the compression space completely.

The exhaust cam, Fig. 17, is designed to lift the valve 9/16 of an inch and hold it open during 218 degrees of the revolution. It should open 35 degrees before the lower dead center is reached and close at 3 degrees past the upper dead center, which allows 6 degrees of the revolution between the closing of the exhaust and the opening of the inlet valves. To locate these cams the engine should be assembled with the cams loose on their shafts, whereupon the cams should be set, clamped to the shaft and tried until they lift the valve at the proper time. If they close the valve at the proper time a hole can be drilled through the cam and shaft, and a tight pin driven through and filed off smooth with the face of the cam.

The cams should be made of a good grade of steel, finished as smoothly as possible on their wearing faces and case hardened.

Valve Rod.—The valve rod, Fig. 14, should be turned on the stem so that it will fit snugly and yet work freely in its bearing in the base. It can be made of ordinary carbon steel, with the end forged so as to provide a bearing for the roller on the cam, to prevent undue wear. The roller, Fig. 15, should fit snugly in its slot in the valve rod and yet work freely in the slot, as well as on the pin which forms its axle. The pin should be peened into the rod on each end to prevent its working loose. The cam roller should be case-hardened.

The valve rod should have 1/16 of an inch opening between it and the valve stem when the engine is all assembled and ready to run.

Flywheels.—The flywheels, Fig. 21, of which two are required, should have the correct weight to run ordinary machinery, but for special work they must necessarily vary from this weight. For example if the engine is used to run an electric light dynamo, the flywheels must be from ¼ to 1-3 heavier than those specified. This extra weight can be obtained by increasing the thickness of the rim on the inside diameter.

The flywheels should be perfectly balanced so that they will not interfere with the running of the engine. This can be done by drilling out the hub so that it will fit the crank shaft, inserting a loosely fitting bar, each end of which rests on trestles, so that the sides of the wheel will be plumb. When the heavy parts of the wheel settle to the bottom, weights can be fastened to the upper inside rim until the wheel is perfectly balanced. It is also the practice to drill holes in the rim and to fill them with lead.

The flywheels should be turned on both sides and the face of the rim. If a large enough lathe is not available the wheel can be turned at the foundry at little expense, as most foundries have a machine shop. The base can also be planed off at the top and bottom in the foundry.

Accessories.—The accessories to this engine can be

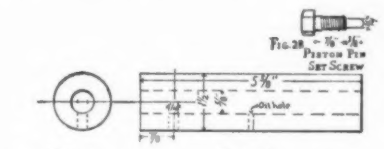


FIG. 29A FIG. 29
PISTON PIN

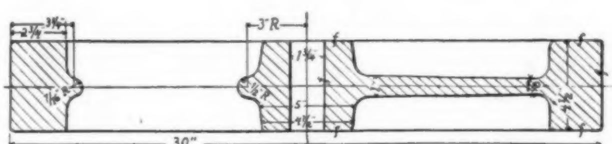


FIG. 21A
SECTION THRU A.B.C.

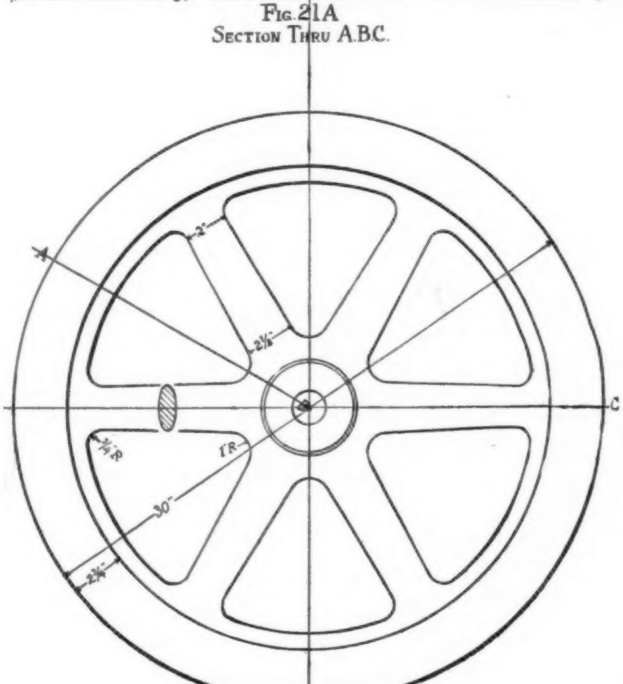


FIG. 21
FLYWHEEL
CAST IRON
2 REQUIRED

STEEL OR BRONZE FIG. 22
CAM SHAFT GEAR ON CAM SHAFT A IS 1". AUX " A IS 1⅛

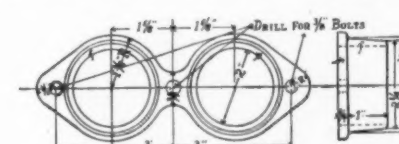


FIG. 27 FIG. 27A
GLAND FOR INLET & EXHAUST CONNECTIONS
CAST BRASS

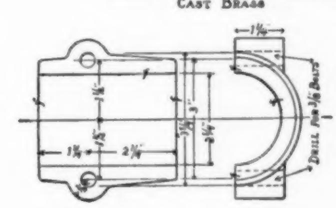


FIG. 26 FIG. 26A
CAP FOR MAIN BEARING OF CRANK SHAFT
2 REQUIRED
CAST IRON

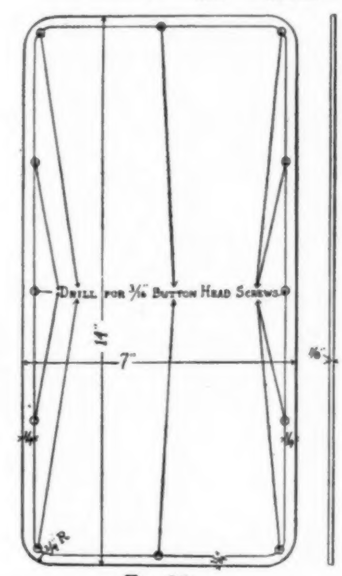


FIG. 23
PLATE FOR HAND HOLE IN BASE
SHEET STEEL OR BRASS

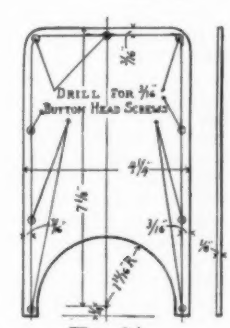
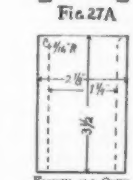


FIG. 24
PLATE FOR CRANK SHAFT HOLE IN BASE
SHEET STEEL OR BRASS

FIG. 27A



FINISH ALL OVER
FIG. 27
MAIN BEARINGS BUSHING
4 REQUIRED
CAST BRONZE

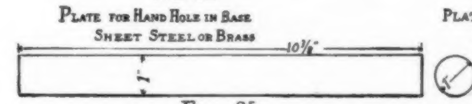


FIG. 25
CAM SHAFT
ROLLED STEEL

bought in the open market and include a carbureter for mixing air with the gases before they enter the cylinder. To this carbureter a governor should be attached. Although the engine will run without the aid of a governor, its steady running is better controlled by the use of one. With a little added mechanism the governor could be attached to the inlet valve so as to control its lift. Other accessories needed are a spark plug, of which two or three should be kept on hand in case one should give out, a spark coil, switch and batteries, or a magneto in place of the spark coil. A muffler may also be desirable to deaden the noise from the explosions; but if the exhaust is led from the engine through a 2-inch pipe, which increases in diameter to 2½ inches under the floor to 3 inches for a length of about 6 feet on the outside of the building and to 3½ or 4 inches for the balance of the distance, the sound will be deadened so that the exhaust is hardly heard.

This engine is designed to give a M. E. P. of 60 lbs., compression 60 lbs., explosive pressure 200 lbs., with the normal speed of 325 revolutions per minute. At this speed it should develop five actual horse-power. The horse-power will depend largely on the quality of the gas used. Some natural and coal gases may not be able to develop over 4 horse-power. With illuminating gas the engine may easily be run up to 7 horse-power. Any of the explosive gases may be employed. If a special carbureter be used that would start and run the engine with gas until the cylinder was sufficiently hot, kerosene may be turned in to take the place of the gas, with good results.

THE UTILITY OF INVENTIONS.*

By John E. Brady.

The laws of the United States provide that patents may issue for any new and useful art, machine, manufacture, etc., under certain conditions, and hence it follows that, in order to be patentable, an invention must, among other attributes, disclose utility. It is not sufficient that an invention be new; it must be useful as well, or it cannot be accorded the protection of the patent laws. By useful invention is meant such a one as may be applied to some beneficial use in society in contradistinction to an invention which is mischievous or injurious to the morals, the health, or the good of society. A useless invention, even if patented, is not and never will be of any profit to the public, and the patent granted thereon is void. New inventions in regard to some trifling article of dress, such as "hoops, or crinolines," or, in the language of Judge Story, "a new invention to poison people," are not patentable. The one is frivolous and the other mischievous. Page vs. Perry, 1 Fish. Pat. Cases 298. Utility, as predicated of inventions, means industrial value; the capability of being so applied in practical affairs as to prove advantageous in the ordinary pursuits of life, or to add to the enjoyment of mankind. But a mere curiosity, a scientific process exciting wonder, not yet producing physical results, or any frivolous or trifling article or operation not aiding in the progress nor increasing the possessions of the human race, whatever be its novelty, and whatever skill has been involved in its production, does not fall within the class of useful inventions nor become the subject matter of a patent. Robinson on Patents, Vol. 1, p. 463. In Crouch vs. Speer, 1 B. & A. Pat. Cas. 145, it was said that the test whether an invention is useful in the sense of the patent law is not whether it is not mischievous or hurtful, or insignificant, but whether it is capable of use for a purpose from which some advantage can be derived. If it be useful in this sense, the degree or extent of its usefulness is altogether immaterial. It is not necessary that it should be the best means of producing a desirable result, but a means, although inferior to others, of producing it.

Inventions which accomplish definite practical results may nevertheless possess such attributes as destroy the benefits that otherwise they would bestow upon the public. Inventions whose chief or only value resides in the facilities which they afford to men to perpetrate some wrongful injury either by fraud or violence upon each other, are thus regarded as destitute of real utility. For the same reason arts or instruments which, if completed and in actual use, might be of benefit to their employers, are sometimes held to be devoid of real utility on account of the great risks incurred in their construction. The courts, in their consideration of this subject, must necessarily contemplate the entire scope and effect of the invention, as well upon the maker and operator as upon the consumer; and if the net result to the community at large is not a benefit, the inventor has no claim upon the public.

The acts of Congress which authorize the grant of patents for designs, were plainly intended to give encouragement to the decorative arts. They contemplate not so much utility as appearance. The law manifestly recognizes that giving certain new and original appearances to a manufactured article may enlarge the demand for it, may enhance its salable value, and may be a meritorious service to the public. It, therefore, proposes to secure for a limited time to the producer of those appearances the advantages flowing from them. Gorham Company vs. White, 14 Wall (U. S.) 511. Utility is not negatived by the fact that the manufacture covered by the patent has no function except to decorate the object to which it is designed to be attached. In such cases utility resides in beauty. Whatever is beautiful is useful, because beauty gives pleasure, and pleasure is a kind of happiness, and happiness is the ultimate object of the use of all things. Walker on Patents, p. 73. The Westinghouse Electric & Manufacturing Company, being the owner of a design patent (No. 24,416) issued March 22, 1902, to Albert Schmid, brought an action against the Triumph Electric Company, seeking to enjoin the latter from infringing its alleged rights under the patent. The patent involved covered a design for a configuration of a frame for electrical machines. It was held that the word "useful" in the section regulating the issue of design patents does not require that the shape or configuration of an article, in order to be patentable, shall add some new utility to the article, but is used merely for the purpose of excluding such things as might have a vicious or corrupting tendency, and that a new and original design for an article may be patentable where it merely improves its appearance. But it was further held that, assuming that a frame for an electric machine might be made the subject of a design patent, the frame design in question was not properly patentable for the reason that it was neither new nor original in view of the existing state of the art. The only originality which the counsel for the complainant could reasonably claim for the design patented was found in the curvature of the bases of the pillars for supporting the shaft and of the supports to the cylinder frame for the field; and these were considered differences which would suggest themselves to any workman, and which did not involve the exercise of inventive genius, which is as essential to the validity of a design patent as it is to the validity of a mechanical patent. Westinghouse Electric and Manufacturing Company vs. Triumph Electric Company, 97 Fed. Rep. 99.

It seems that utility is negatived if the function performed by the invention is injurious to the morals, the health or the good order of society. Thus, an invention to improve the art of forgery, or one to facilitate the spread of a contagious disease, or one to render water or air intoxicating would, of course, be unpatentable for want of utility. The more completely such an invention could perform its function the more objectionable it would be in this respect. Walker on Patents, p. 73. In the case of National Automatic Device Company vs. Lloyd, 40 Fed. Rep. 89, the complainant moved for an injunction restraining the infringement of a patent for a "toy automatic race course." The device covered by the patent consisted of a shaft projecting upward from the center of the base of a circular shell or case, to which shaft a clockwork mechanism was so geared that it could be made to revolve rapidly by releasing the escapement of the clockwork. On the shaft were mounted two or more radial arms, to the ends of which were attached small toy figures of horses. The clockwork was released by dropping a coin through a slot in the machine, whereupon the shaft would revolve, carrying the radial arms with it, for a short time, when the clockwork would be shut off, allowing the arms to revolve of their own momentum. The proof showed that the only use to which the device had been put was to install it in saloons and other drinking places, where the frequenters thereof might lay bets as to which toy horse would be the last to stop or would stop nearest a certain designated point; in other words, the machine was used only for gambling purposes. For this reason the machine was held not to be a benefit to society or "useful" within the contemplation of the patent act, and the patent was declared void. It was urged that the machine was susceptible of being utilized as a toy or child's plaything, but the fact that no such use of it had been made was considered a sufficient answer to that contention.

Inventions the object of which is to afford amusement and diversion, are classed among patentable subjects; but only the mechanical agencies employed can be patented. Under this rule it was held that the patent of the Paul Boyton Company, covering an inclined gravity railroad terminating in a body of water, which provided an amusement popularly known as "Shooting the Chutes," was invalid, one of the reasons being that, in view of the old art of launching ships, there was no patentable novelty in the combination of an inclined railway located near a body of water and a boat-shaped car or toboggan, adapted to move downward over the railway and be propelled forwardly upon the water by the momentum derived from its descent. Paul Boyton Company vs. Morris Chute Company, 82 Fed. Rep., 440.

In the Cushman case, 1 McArthur's Pat. Cas., 569, an electrical patent was refused on the ground of the absence of utility and an appeal was taken from the decision of the Commissioner in so refusing. The device for which a patent was sought consisted of an improved method for protecting objects from the effects of lightning by surrounding that part of the lightning rod which is imbedded in the earth with a galvanic battery. Its construction and functions were described by the inventor in the following language: "To facilitate the discharge of the electricity from the conductor to the earth is the object of my present invention, and it consists in surrounding that part of the lightning rod imbedded in the earth with plates of dissimilar metals, arranged in such manner as to constitute an open galvanic battery. Electromotive power will divide the electricity on the metallic plates and, as they are insulated, they will act as a conductor of the electricity that is opposite to that of the air. Should there be a high electrical tension of the air, by this means the electrical fluid conducted through the rod is more readily discharged by uniting with the opposite electricity as it accumulates on the surface of the plates. When the discharge flows from the earth to the air, then the rod conducts from the plates such electricity as is opposite to that of the air." The reason which the Commissioner gave for refusing a patent was that the intensity of the action arising from either the copper or the zinc plate, or both, in the earth, is thousands of times too small to be sensible as compared with that of a flash of lightning. "The latter has force enough to strike through hundreds or thousands of feet, or sometimes through miles of air. The former has not force enough to strike through the thousandth part of an inch. These are well known facts and the thing must be entirely without practical effect." The court was satisfied that the device in question could be put to no beneficial use and the Commissioner's refusal was affirmed.

The degree of utility is not material and a patent may rightfully issue, so far as that quality is concerned, provided the invention be of some use and benefit. Nor does the simplicity of a device indicate in any way the absence of utility, for this is a recommendation of the usefulness of the article rather than an objection thereto. The existence of utility in an invention is not to be determined by comparing it with other arts and devices, but is rather to be ascertained by an examination of the particular art or device in question. It is not essential to the patentability of a device that it should supersede or be superior to others previously used for the same purpose; nor does the fact that an invention has been displaced by some subsequent invention import a lack of utility. If, however, a patented article rapidly takes the place of all others of similar kind and is successful commercially, these are considerations tending to show that the public welfare has been advanced by its production and that it is characterized by utility within the meaning of the patent laws.

* Electrical World.

PEAR-SHAPED STARS.

By Alexander W. Roberts, B.Sc.

Ask ten men what is the shape of every star that shines in the brow of night, and nine out of the ten will at once reply, with all the assurance of settled conviction, "Round like a globe." And thus it happens that when the mathematician or the astronomer reveals to our knowledge the existence of such strange stellar forms as egg-shaped, pear-shaped, or even cigar-shaped stars, our mind rises against such apparently deformed orbs in a kind of revolt. Like children of a larger growth, we say to ourselves, "I *know* that the stars must be as round as a billiard ball; if it does happen that there exist somewhere in the great reaches of space stars shaped like a pear or an egg, then these bodies must be stellar freaks, sports in the well-ordered economy of Nature. They have little, and can have little, in common with such spheres of light as Sirius, Canopus, or Vega."

Thus do we reason unreasonably, for a pear-shaped star is neither a freak nor a monstrosity; and, instead of such bodies having nothing in common with the more highly developed suns that shine in our sky as stars, they represent the first stage in the evolution of those systems, stellar and solar, that impress all minds by their grandeur and majesty. A pear-shaped star is, indeed, a kind of celestial ugly duckling; one day its strange, lop-sided figure will give place to a stellar system, perfect in its form, harmonious in its movements. Our own sun, for instance, now a star in the fullness of its beneficent manhood, with all its grown-up family of planets and moons clustering round it, a perfect sphere of life-giving flame, was, ages ago, in all probability a pear-shaped mass of chill, nebulous matter, a vast, kite-shaped figure, shedding worlds—Neptune, Uranus, Saturn, Jupiter, Mars, the Earth, Venus, and Mercury, as it contracted, and still contracted, through untold flights of time.

It is thus that Nature always works. There is no stagnation, no fixity of type, in her ample dominions. Whether it is the great majestic worlds that fill the night with beauty and splendor, or the myriad grains of sand that give a silver girdle to many a sea, each and all come under the despotism of the same inflexible laws of development as regards form and structure and movement. The form of each stellar orb and orbit, the shape and position of each grain of sand, are ever changing, "ever giving place to new," under the stress and strain of compelling circumstances.

What is a central sun to-day, a perfect ball of fire and flame, must ages ago have been a lop-sided mass of cosmic dust, a bulging, nebulous cloud, slowly revolving and yet more slowly contracting. A pear-shaped star, instead of being an anomaly, is therefore a link, one of the first links, in the great chain of events that connect the present time in our world's history with that far-off day in the beginning of things when our "good green earth" was without form and void, and darkness covered the yet unborn world in its generous folds.

But to come to the heart of our subject: what actual proof have we that pear-shaped stars *do* exist? The theoretical reasons for their existence are many and unchallenged. Years ago such mathematicians as Darwin and Poinedrè, with the spirit of prophecy upon them, delineated the form and fixed the place in cosmic history of such stars. Theirs was one of the "visions splendid" of astronomy; but has the vision become one of the realities of practical science? Philosophy demands the existence of pear-shaped stars as the material, the raw material, out of which stellar systems, binary and multiple, sirian and solar, are fashioned; but has any one seen them with his bodily eyes? The

es of faith did truly discern them decades ago; but ith is not everything in science!

It is all very well to say that stellar evolution mands this form of star as the progenitor of more veloped systems. The question that the ordinary an puts is: Have we seen such stars, measured their regular form, estimated their oblateness, photo-aphed their unfamiliar form? We must confess that o one has as yet done any of these things *directly*, r with the largest telescope in the world the bright-t known pear-shaped star, Beta Lyræ, appears simply a point of light. No stellar disk is visible, or deed ever can be, as all the stars are too remote from rth for that to be possible. "Then, how do you now, apart from theoretical considerations and proof, at Beta Lyræ, or any other star that shines in the y, is pear-shaped if its outline has never been seen?" a question I think I hear asked, and with some ow of reason, for to many it may seem a strange ing to write an article on a phenomenon no one has er actually seen. To such readers, the gulf between conviction that some stars in the sky are probably ar-shaped, and the certainty, born of actual evidence, at this, and this, and this star *is* pear-shaped, is as de as that between a dream and a reality.

Now, let me try to explain how astronomers are able say that this, and this, and this particular star is ar-shaped; and how they are further able to meas-re, roughly no doubt, the flattened figure of these ars. In 1905 the scientific world was deeply inter-ted in an important total eclipse of the sun which ok place in Spain. Men traveled over continents d seas to observe it. They knew the exact hour hen it would happen. For years before its occur-nce astronomers had calculated, with almost perfect ecision, the moment when the eclipse would begin any given spot, how the obscuration would increase, hen it would be total, and how and when and where e dark shadow would disappear from off the sun's ce.

Now, all these calculations were based on the sumption that the sun and moon are practically heres—a true assumption. If they are not spheres, d if the calculations were founded on the assump-on that they are, then there would be important screpancies between the times of eclipse as theory edicted them and actual observation noted them. put the matter still more plainly: suppose that e moon is of the shape of an egg and the sun of the rm of a pear, it will be at once evident that the nner, duration, and date of eclipse will be some-at different under these conditions from what they uld be if the sun and moon were spheres. Thus, ce the disks of both bodies are considerably elon-ted, the duration of eclipse will be correspondingly gthened. There will also be a pertinent difference the character of the eclipse. The sun and moon ing no longer spherical, there would be a distinct nt of symmetry between the decreasing and increas-g phases. Indeed, there would be a hundred and one ch differences, all due to and depending on the pecu-r form of the eclipsing stars. But just as astrono-rs are able to tell us all about an eclipse on the sumption that the eclipsing bodies are perfect heres, so could they tell all about an eclipse, its ration, its extent, its character, if the bodies were any other shape. The calculations would be a little re troublesome, but they would not be unsurmount-le.

Now, let us turn our eclipse problem the other way out. Let us suppose an astronomer who does not ow the shape of the sun or the moon to observe a ar eclipse. He watches its beginning, the time and ce; with a photometer he measures the steady crease in brightness of the sun, he notes the time of ch observation, he determines the moment of great-t darkness; he carefully measures the decrease of lipse, its rate, its duration, its character; finally, he termines the whole brightness of the uneclipsed sun. hen our astronomer has marshaled all his observa-ns he has the data necessary for a fairly accurate termination of the *shape* of the sun and moon. He es not require to look at these bodies, or to measure em, or to photograph them. His eclipse observa-ns give him all the information he wants. When has dealt with his figures and facts he can tell us hether our satellite is circular, elliptical, or oval th as much certainty as if he had placed it between ging rods.

It is in this reversed form—namely, to find the shape two eclipsing bodies from the circumstances of their lipse—that the problem presents itself to those who llow out the search for pear-shaped stars.

We have in certain articles already published in s journal written concerning stars that vary regu-ly in brightness, because their light is eclipsed by a cling companion. Such stars are called Algol vari-es, and they wax and wane in brightness after the shion of the winking eye of a lighthouse. Now, hough the ebb and flow of light of an Algol star ms very different from the majestic wave of night t sweeps swiftly across the sun's face during a ar eclipse, it is a difference in intensity and range, t in kind and character. The sun is near us; the rs are indefinitely remote. When we witness, there-e, the fluctuations in brightness, the steady waning d waxing of light of an Algol variable star, we know t we are simply watching a solar eclipse away out the far land of stellar distances; and the same geo-trical laws of sunlight and shadow govern both ipses—those of our sun, those of an Algol variable r. If the obscuring body is spherical, the eclipse will take place in a given definite manner; if the obscuring body is not spherical, then there will be a distinct departure from the regular symmetrical eclipse which takes place under the former conditions—*that is, if we have observed carefully a stellar eclipse we are in a position to tell the shape of the eclipsing stars*, and our conclusions will be as assured as if we examined, measured, or photographed the occulting disks.

When, therefore, a star has been observed to vary in brightness in such a manner as to indicate that it is an eclipse or Algol variable star, a watch is kept over all the vagaries of its variation in order to arrive at a determination regarding the shape of the star. The observer determines the instant when the star begins to decrease in brightness—that is, he observes the beginning of eclipse; he measures with all possible accuracy the decrease in brightness, its rate and duration; he fixes the instant of greatest eclipse; he compares the increasing phase with the decreasing, in order to detect any want of correspondence between the two; finally, he estimates the amount of brightness of the star when uneclipsed. All these facts ascertained, he is in possession of definite knowledge regarding the shape of the eclipsing stars. He is in possession of a good deal else besides this, but one concern at a time must satisfy us.

Up to the present the researches of astronomers in the direction we are now considering have been to reveal the existence of ten pear-shaped stars, five in the northern and five in the southern hemisphere. This may seem a very meager harvest to those who are unacquainted with the difficulties that attend the search for such stars. To those who do know and understand the difficulties, the discoveries already made would seem to indicate that the number of pear-shaped stars in the universe is much greater than one is inclined to allow. Yet, that a not inconsiderable portion of the material universe should be in the morning of its long, long day is not surprising, surely. The ten stars discovered represent all degrees of oblateness, from bodies almost as elongated as a torpedo to orbs nearly spherical in form.

Of the ten stars, or rather systems, two are of special interest. In the case of these two systems the component stars are so near one another that they touch, and at the point of contact they merge into each other. It is very difficult, therefore, to say what exactly is the shape of these figure-of-eight stars. Such a system must be in a state of the most unstable equilibrium; and one day the centrifugal force will prove too strong for the slender, ever-changing nexus that binds the twin companions together. In that day *snap* will go the connecting link. When this takes place there will be for both stars a period of stupendous unrest. From center to circumference the vast bodies will oscillate in great swelling pulsations, gradually dying down to a sobbing dispeace. Thus are worlds born!

Two important facts emerge from a closer study of our ten pear-shaped stars. First, the nearer two companions of a system are to one another the more oval are they in form; second, there is distinct evidence, in the case of at least two of the ten systems, that the component stars are slowly receding from one another.

An acquaintance with the laws of gravitational physics would lead us to expect the first of these conclusions; for the power of any body to distort or to raise tides upon another body depends on the distance the two are apart. We have in our own tides a striking example of the force which a small body exerts upon its primary, even when that pull is considerably weakened by the long distance over which it has to travel. Under the compelling stress of the moon's attraction, as we all know, a great swell of waters, in rhythmic surge, sweeps round the globe, bringing to estuary and harbor, river mouth and landlocked bay, the rise and fall of the cleansing, purifying sea. What would the gigantic strength of the moon's tide-raising force be if it were fifty times nearer our earth than it is? In that case its irresistible pull would pile the waters of the ocean into a tide sixty miles high; the terrific lateral strain would crack the rocky ribs of earth as a man cracks a walnut. With a moon circling at our very doors the earth would no longer be an orange-shaped globe; it would be a pear-shaped world. But what a world: air and sea and shore reverberating with the thunder of creaking, grinding rocks, and the wash and boom of great tidal waves—a dead world!

The second fact also follows naturally from a well-known law of stellar dynamics. The law is this: if two bodies are near enough to raise tides on either of them, this very expenditure of tide-raising energy shoves the circling bodies farther and farther apart in an ever-widening spiral. The forces, therefore, which tend to bind two stars together—namely, their attraction—are in reality the means of their separation and disunion. The reflex action of the tides is to gradually weaken the power to raise them. Thus does Nature most harmoniously work out her great schemes for the evolution of worlds and systems of worlds.

Given the operation of these two great laws, it is easy, I think, to predict what the future history of a pear-shaped system will be. We can trace its development from the moment of its birth as a dual unity right on to the day when, after much travail, it has become a system of worlds where life is possible and probable. The fissiparous principle—which seems as inherent in matter as it is in the lower orders of animals, and of which the pear-shaped form is the outcome—compels the rotating, tenuous, unstable mass to shed at vast intervals its brood of infant worlds. But this disintegration does not go on for ever; another, and a third, law supervenes to prevent practical annihilation, or else the universe would become an aggregation of infinitesimal grains of matter, finally dissolving into space and leaving "not a wrack behind." The conserving and preserving law to which we refer is that which compels a gaseous body to go on contracting until at last its density is so great that further contraction is impossible. When this end is reached disintegration ceases.

Now, if we are thus able to look down the endless corridors of time, and to witness the slow evolution of ordered systems from a primeval egg-shaped mass of world-stuff, what is to hinder us from looking backward over the way we have traveled? May we not retrace our steps until we reach that natal day when our earth rose into being as a gaseous wart on the misty folds of a nebulous sun? But if this way be too far for even the keenest vision, we may follow with sure sight the life story of our planet back to the hour of the moon's birth.

We have already stated in this article that theory demands for the genesis of our satellite a Siamese-twin, pear-shaped, earth-born system; and we have seen that analogy supports the demand. Now, there are those who, perhaps overventuresome, point to the very spot where our satellite broke away from its mother-earth. They tell us that over the spot where the Pacific Ocean now rolls in long silver waterbreaks, the moon gathered to itself a separate existence, and that under the surface of this spacious stretch of sea, full three thousand fathoms deep, may still be found the scars which mark the place where a world was born.

When was this birthday? In the beginning of things, is about the most satisfactory answer we can give. But if we wish to place some reasonable span between that vague "beginning of things" and the present day, we may state, yet with some hesitation, and with no small uncertainty, that at the very least one hundred million years measure the moon's' age as a separate world.

A burnt-out cinder, a dead world, a desolate land of fierce extremes of heat and cold, are the names we hurl at the friend that has companioned our earth for over a hundred million years. If it is dead, a dried-up cinder, a furnace and an iceberg by turns, it has had its day of good things. It was once so near the earth that it modeled its mountains and seas; but as the years came and went it drifted farther and farther away, till at last a heave of the ocean in greeting is all earth has to give to its eldest born.

What the future of our own planet may be does not concern us here; an excursion into such a field of inquiry does not fall within the area of an article on pear-shaped stars; but the question is certainly of interest, and I hope at a future opportunity to indicate what answer science has to give to it.

Now we return to the point from which we started, and we have to modify a certain thought expressed in the opening paragraphs of our article. After all, a spheroidal world bears the last touches of Nature's kindly formative hand. A round globe is the finished product of many evolutions; and if our minds have grown instinctively abhorrent of pear-shaped stars, it is because life as we know it on such tide-distressed worlds is an utter impossibility. Their substance is as diaphanous as a summer cloud; in the space of a few hours their huge bulk, sometimes as much as three hundred million miles in diameter, contracts and expands through a range of over a million miles. Storm and strain are the spirits that brood over their vast, tumultuous, shoreless wastes; there is ever the clash of atoms and the surge of sorely tossed titanic waves. Majestic in their spaciousness, impressive in their stupendous movements, their importance, their human attractiveness, lies in their potentiality, in their promise. They are worlds in the making.—Chambers's Journal.

Col. R. E. Crompton has devised a new measuring machine, combining accuracy with rapidity in working. With this measuring machine, which has been designed for observing length differences due to the heat treatment of specimens of steel, measurements of objects from 1 inch to 6 inches long, not differing among themselves more than a quarter of an inch, can be made and entered on the test sheet at the rate of one per minute. The accuracy obtainable is greater than 1 in 200,000. The end pressure is obtained by a spring and electric contact. The accuracy is due to extreme solidity of construction, 100-thread per inch screw 4 inches long in the nut, which is corrected by a spiral profile device.

New vegetable products of hitherto unknown composition were recently exhibited at the Royal Society. (*a*) Wax of the Raphia palm of Madagascar (*Raphia ruffia*), obtained from the leaves. This consists principally of two solid aliphatic alcohols, the chemical constitution of which is at present under investigation at the Imperial Institute. (*b*) Oil of *Origanum hirtum*, or *onites* of Cyprus. This is found to contain cymene and carvacrol, together with a new terpene and alcohol. It has been introduced into perfumery. The oil of another thyme, *Origanum maru*, of Cyprus, closely resembles oil of marjoram. It contains terpinene, terpinenol and a new crystalline alcohol ($C_{10}H_{17}(OH)_3$), which is at present under investigation. (*c*) Oil obtained from the *Pimenta acris* of Mauritius. This oil contains phellandrene and eugenol, and may be of value in perfumery.

ELECTRICAL NOTES.

The weakest point in electrical transmission is the absence of proper means for storing electrical energy on a large scale at a reasonable cost. This requires that the whole plant be capable of supplying current at the greatest rate still likely to be called for any moment, and still provide an ample reserve of capacity in case of a breakdown in any part of the system. In this connection, the advocates of gas claim that this latter power can be readily and cheaply stored in quantity, for any desired length of time, and used at whatever moment and in any amount without deterioration or loss. The plant, if necessary, may be shut down for a time without interrupting the supply. Until recently, however, it has not been considered possible to convey gas with any success over long distances. This has been due to a lack of efficient compressors, and of pipes and joints not capable of withstanding, without excessive leakage, the pressures which would have had to be employed. With air compressors having a total efficiency as high as 77 per cent, and steel pipes capable of carrying high pressures and obtainable in longer lengths, thus reducing the number of joints, gas is becoming a power which in many cases compares favorably with electricity.—Engineering and Mining Journal.

The ancient town of Damascus is now coming into line with modern progress, and not long ago inaugurated a system of electric lighting and tramways which is well laid out. As to the tramway lines which are now in operation, they are running within the city as well as to connect with the two suburban localities of Meidan and Salahujeh. It is expected that owing to the success which the tramways are meeting with since they have been opened up, they will be increased in the near future. The city is now lighted by 1,000 arc lamps and a considerable number of incandescent lamps. The electric lighting on the outside of the principal mosque is quite striking when the lamps are illuminated for certain special occasions. A large Turkish company known as the Ottoman Tramway Company is operating the traction lines. With it is connected the Brussels Local Railway Company. Current for the different circuits is obtained from a hydraulic plant which is erected at 25 miles distance from the city at El Tequieh, and the Barada falls are utilized to obtain the power which is needed. From the same point the city water supply is taken. In the turbine station erected not long since there are now installed about 1,000 horse-power in turbines. To these are connected the dynamos, which are operated on the three-phase system, using transformers to raise the voltage for the power line going to the city. In town is erected a substation which receives the power line and has a number of motor-dynamo groups for lowering the tension so as to supply the lighting and mains and the tramway feeders. A Berlin company installed the electric outfit in this case. Damascus is the first city in Turkey which has such an extensive light and tramway system.

In a paper read before the Academie des Sciences, M. T. Argyropoulos gives an account of his experiments with speaking condensers. Several physicists such as Wright, Varley, and Garnier have already made experiments with singing condensers. The author succeeds in producing a condenser which speaks very distinctly and with a loud voice. In order to do this, he takes a powerful microphone and a transformer composed of strips of iron forming a core from 1.2 to 1.6 inches thick, upon which are wound two circuits of insulated copper wire of 2.5 millimeters gage and about 250 feet long. One of these circuits is connected to the microphone, using four cells of storage battery in the circuit. On the other hand, he takes a condenser formed of tinfoil and strong paraffined paper, having a capacity of 7 microfarads. The two ends of the condenser are connected with a source of constant current at 220 volts by means of the second circuit of the transformer. This point especially constitutes the novelty of the experiment. In one room he places the microphone, in another closed room the transformer and in a third room, also well closed, the condenser, in order to be sure that it is the condenser which produces the sounds. The sounds of the voice when spoken before the microphone are very distinctly and clearly heard by all the persons who are placed in the room with the condenser. He finds that the intensity of the voice which is given by the condenser increases with the difference of potential which is kept between the condenser coatings. The capacity as well as the construction of the condenser also have an effect upon the sounds. In the present experiments he was not equipped for varying the conditions of working as might be desired, but expects to do this in his succeeding experiments. In this way he succeeds in causing articulate sounds to be given from a condenser, by using a separate source of current to bring it to a constant potential of 220 volts or even more.

Some important developments in electric traction in Genoa are reported in a recent consular communication. In the first place, the State railways are said to have adopted Engineer Corsa's scheme for electric traction on the railway lines through the Giovi tunnels over the Apennines, and to have invited several well-known firms to present estimates for plant, central power station, electric engines, etc. It is said that electric traction would double the present potential traffic on the lines over the Giovi pass, and relieve the present congestion. The Genoa Electric Tram Company, again, propose to construct three "secondary" electric traction lines to Pontedecimo, Sestri Levante (extendible later to Chiavari), and Voltri, on private roadways—i. e., without using the public roads except at crossings. This would permit of a speed impossible on public roads, and relieve some of the railway passenger traffic in the immediate neighborhood of Genoa. The company estimate the cost at £2,000,000, and the project is favorably commented upon in the local press. It will probably be carried out if the communes interested approve and co-operate. The statistics of the company for 1906 are as follows: Total length of lines, (131.812 km.), 81.855 miles; length of lines worked, (129.905 km.) 80.681 miles, including the funicular railway (1.38 km.) and the omnibus service (6.17 km.); car stock—motors, 214; trailers, 110; funicular, 4; omnibuses, 35—total, 363; distance run, (10,075,479 km.) 6,256,872 miles; passengers carried, 46,589,791; total receipts, 6,453,094 lire 69 c.; total expenditure, 4,230,864 lire 21 c.; gross profits, 2,222,230 lire 48 c.; persons employed by the company, 1,421. In addition to the enterprise displayed in the above direction, a great deal of activity is being shown in electrical engineering in Italy. Some capitalists at Milan and Savona have formed a company for setting up electric power works in the valley of Albenga, with a view to supplying the principal industries, and, eventually, a tram service along the Western Riviera with electric motor power. Several of the most important iron and steel works have promised their support to the undertaking.

SCIENCE NOTES.

From a comparison of observations of the rotation of Jupiter during various periods, Mr. Stanley Williams finds a distinct difference. Thus the period determined from the series of observations for 1905-6 is 9h. 55m. 41.46s., while the 1904-5 observations resulted in the value 9h. 55m. 41.57s. The determinations from the Red Spot Hollow vary according to whether they are made from one opposition to another or during each opposition. The difference may amount to 0.5 second. The observations were made with special care to avoid systematic error.—Astronomische Nachrichten.

M. de Morgan the eminent French archæologist, who has been directing the excavations at Susa, in Persia, states that some interesting finds have come to light within a recent period. Among these are a silver cup and a fork belonging to the Sassanide epoch, and these two pieces show fine workmanship and are in a good condition. Below this level, and about 15 to 30 feet depth were found two scale weights having the form of a duck and bearing inscriptions, also a headless statue of yellow limestone half life size and also having an inscription. A stele of diorite has on one side a seated divinity and two persons in a standing position. The other side is covered with a text. The stele is about three feet in height and is well preserved. A large fragment of an inscription of the Hammurabi epoch engraved upon diorite was another specimen, also a life-size statue of a seated person with an incomplete archaic text. This statue shows a remarkable workmanship and is a fine piece of Chaldæan art; it seems to have been brought from Chaldæa to Susa. Many bricks carrying texts of the Patesi epochs were brought to light. The excavations which were carried on during eleven months in one of the "tells" or large mounds, with a hundred workmen, brought to light the ruins of a villa of the Sassanide epoch, built of brick. The walls are now from 12 to 16 feet in height, and the area is about 100 feet square. After carefully taking the plans, he was obliged to demolish it, as it would no doubt have been destroyed by the nomads, and he expected some finds underneath. In fact he came upon some prehistoric pottery which led him to believe that there had been an ancient burying ground on the site.

Spongy chromium is a new form of the metal which a French chemist, Binet de Jassoneix, has succeeded in producing. M. Moissan showed that chromium was slightly soluble in copper when the former was prepared in the electric furnace. By heating chromium combined with boron to a high temperature in the presence of a large mass of copper, we might think that the latter would dissolve the excess of chromium and cause the formation of crystalline compounds of chromium and boron, by a process analogous to that by which P. Lebeau prepared several of the silicides. But the experiments led to other and interesting results. Cast chromium containing 15 per cent of boron was heated in the electric furnace with a great excess of copper. The ingot thus obtained shows that in the midst of the mass of copper there is a white metal in the form of fine filaments or assembled in crystallites like those of snow flakes. Dissolving out the copper, and drying the residue, he obtains a brilliant spongy or moss-like mass formed of very fine filaments interlaced or by crystallites grouped in star form or like moss leaves. The substance is almost all chromium, and did not contain more than 1 or 2 per cent of boron, and by heating, the latter could be eliminated entirely. It is observed therefore that combinations of chromium and boron, in presence of copper, are dissociated in the electric furnace. The boron is volatilized off, and the chromium remains in a finely-divided state. The spongy chromium behaves like the ordinary metal, except that it enters into reaction more easily. It is not oxidized in air at the ordinary temperature, but takes fire like tinder and burns on contact with a flame. In oxygen, the glow is very bright. It is attacked by hydrochloric and sulphuric acid, but not by nitric acid. **This chromium sponge is therefore a new state of the metal.**

TRADE NOTES AND FORMULÆ.

To Prevent Labels on Tin Cans from Coming Off.—This can be done by moistening the backs of the labels with glycerine before applying the adhesive. The glycerine, it is claimed, will prevent the adhesive from becoming completely dry and brittle.

Billiard Ball Composition.—Set 80 parts by weight of bone gelatine (Russian glue) and 10 parts of Cologne glue to steep with 110 per cent of water. Heat it in a water bath and add 5,000 parts of heavy spar, 4,000 parts of chalk, and 1,000 parts of boiled linseed oil. Small rods, formed from the same material, are dipped into the mixture, and the quantity that remains attached to the rod is allowed to dry; the dripping and drying repeated until finally a rough shaped ball is obtained. When after three to four months it is dry, after being properly turned off, it is placed in a bath of red liquor for an hour, allowed to dry and polished again like an ivory ball.

Cold Polishing Inks.—These consist of saponified varieties of wax colored with nigrosine. Alkaline shellac solutions, and even gum solutions, have recently been used as cold polishing inks, but they produce considerably less luster. A good recipe for making cold polishing ink is the following: Boil 10 parts by weight of purified potash, 200 parts of water, and 250 parts of beeswax in a suitable vessel till the mass is entirely uniform and no watery fluid is separated even when the vessel is taken away from the fire. Then remove the vessel and carefully dilute the viscid mass of boiling water. Place the vessel again on the fire, and stir the mass well but do not let it boil. Gradually add 4,000 to 5,000 parts of hot water to the above quantity of wax. Color black with nigrosine.

To Transfer Pictures to Wood.—Wood surfaces (white woods, lime, maple, poplar, etc.) should first be rubbed smooth with decolorized linseed oil, then dried over a coal fire and given three coats, one after another, of a varnish made of 30 parts of sandarac, 15 parts shellac, 15 parts turpentine, and 375 parts of alcohol (90 per cent). The varnish may be colored at discretion with dragon's blood, turmeric, etc. The engraving to be transferred is thoroughly soaked in salt water and spread on blotting paper, remaining moist. A smooth board, as hot as possible, and screw clamps must be all ready. The wood surface must be again coated with varnish, also the picture, on the printed side. It must then be laid smoothly on the wood surface, over it a piece of flannel, and on that the heated board, and the whole pressed tightly together by means of the screw clamps. After a few hours it will be dry. Rub the back of the picture with linen rags, wet with water, until the greater part of the paper is rubbed off, cover the surface with linseed oil, and rub off any parts of the paper that remain, with the finger. The picture surface can then be rubbed down with linseed oil and linen rags, dried, the surface varnishing repeated ten times, and finally given a coat of copal varnish and polished.

Impregnation of Sailcloth.—First prepare a zinc soap by completely dissolving 56 parts of soft soap in 125 to 150 parts of water and adding 28 to 33 parts of zinc vitriol to the boiling liquid, stirring constantly. The zinc soap will float on the surface, and form when cold a hard white mass, which must be removed and redissolved in fresh boiling water to free it from any alkaline sulphates. Then pour 233.5 parts of crude linseed oil (free from slime) into a boiler with 2.5 parts of best potash and 5 parts of water. Boil the mass till it becomes white and opaque, forming a fluid soapy compound. Add 1.25 parts of sugar of lead, 1 part of litharge, 2 parts of red lead, and 10.5 parts of brown resin. Boil the whole for about an hour, taking care that the temperature does not exceed 100 deg. C. (212 deg. F.), and stir thoroughly from time to time. Now add 15 parts of the zinc soap and stir till the metallic soap has combined with the oil; here also the temperature must not be raised above 100 deg. C. When the ingredients are thoroughly mixed, add a solution of 1.5 parts India rubber in 8.56 parts of turpentine oil and stir till it has thoroughly combined with the mass. Coat one side of the cloth with this compound, which should be 70 deg. C. (158 deg. F.) hot, by means of a brush. Hang the article up to dry and then apply a second coat of the compound at the same temperature, again allowing it to dry. The fibers will now be completely saturated and the fabric rendered waterproof.

TABLE OF CONTENTS.